

HEAVY-DUTY VEHICLE TESTING: Evaluating the Effectiveness of Emission Reduction Options

FINAL CONSULTANT REPORT

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Abstract

The California Energy Commission and the Clean Air Vehicle Technology Center conducted a test program to identify how alternative fuels and after-treatment devices affect particulate matter, nitrogen oxides (NO_x), and total hydrocarbons emissions in heavy-duty vehicles. This project evaluated five fuels; including Arco's ECD-1 Diesel (also known as ultra-low sulfur diesel), Lubrizol's Purinox, and three Fischer-Tropsch Diesel (FTD) fuels. In addition, the project looked at particulate matter and NO_x -control technologies; including diesel soot filters from Johnson-Matthey, Engelhard, and Cleaire; oxidation catalysts from Johnson-Matthey, Engelhard, Cleaire, and Lubrizol's Engine Control System (ECS); and engine recalibration.

Overall, project evaluations determined that all the fuel-technology combinations tested offer significant particulate matter reduction over standard diesel fuel. While NO_x results were more variable, test results indicated that using FTD fuels with passive after-treatment systems lowered NO_x emissions. In particular, active or lean catalyst applications delivered the greatest NO_x reductions. Finally, all combinations of fuels and technologies produced dramatic changes in total hydrocarbons.

Executive Summary

The California Energy Commission (Energy Commission) contracted with the Clean Air Technology Center to provide emission testing for the evaluation of the Department of Transportation's (Caltrans') *Greening of the Fleet Program*. The goals of this project were (1) to determine the NO_x, particulate matter, and total hydrocarbons reduction potential (for ozone reduction purposes) of various technologies used with a variety of commonly used fuels and (2) to help Caltrans secure NO_x and particulate matter retrofit verification under the Air Resources Board (ARB) interim retrofit procedures. This report provides data and an overview of these emission tests and their results.

Technologies and Fuels

Six technologies combinations and six different heavy-duty trucks were investigated, including diesel soot filters (DSF) from Johnson Matthey, Engelhard, and Cleaire; oxidation catalysts from Johnson Matthey, Engelhard, and Cleaire; and engine recalibration. Lubrizol's Purinox was also tested with, Lubrizol's ECS's AZ Puri muffler (DOC technology). All catalysts were first "degreened" for 100 hours by in-service operation. The technologies were tested with six fuels; Standard Diesel, (125-ppm Sulfur, 22.1% aromatics), Arco's ECD-1 Diesel (<15 ppm Sulfur, n.a. aromatics), Lubrizol's Purinox, and three Fischer-Tropsch Diesel (FTD) fuels; including Moss Gas Super (0.0004% Sulfur, < 1.0% aromatics), Moss Gas Premium (0.0005% Sulfur, 8% aromatics), and Shell Equilon (0.0004 Sulfur, <1.3% aromatics).

Results Summary—Particulate Matter (PM)

All the fuel-technology combinations reduced PM emissions significantly. Using FTD fuels and ECD-1 with the PM and NO_x reduction devices provides PM reductions greater than 90% over the baseline configuration. When Purinox fuel is used with a diesel oxidation catalyst, PM emissions are reduced by about 65%, compared to 50% with Purinox use alone.

Results Summary—Nitrogen Oxides (NO_x)

In contrast to the PM reductions, the NO_x effects are more variable. Table 1 demonstrates how NO_x emissions are influenced by the two drive cycles—the New York Business Cycle (NYBC) and the Urban Dynamometer Driving Schedule (UDDS). FTD and Purinox fuels used with passive after-treatment systems (#1, #2, #3 and #5) provided NO_x reductions of up to 28%.

¹² <http://www.arb.ca.gov/aqd/weekendeffect/weekendeffect.htm>

Table 1: NO_x Reduction Summary

Drive Cycle	1.a <i>Lubrizol Purinox vs. Std. Diesel</i>	1.b <i>Lubrizol Purinox with ECS DOC</i>	2. <i>Johnson Matthey DPF</i>	3.a <i>Engelhard DPX PM Filter before reflash</i>	3.b <i>Engelhard DPX PM Filter after reflash</i>	4. <i>Alliance Longview Lean-NOx Catalyst</i>	5. <i>Engelhard DPX PM Filter and NOx Catalyst</i>	6. <i>Alliance Longview w/ NOx Catalyst and PM Filter</i>
NYBC	-19%	-25%	-8%	+1%	-18%	-22%	-4%	-19%
UDDS	-18%	-28%	-1%	-1%	-16%	-38%	-3%	-34%

For active or lean NO_x catalyst applications (# 4 and #6) even greater NO_x reductions were achieved with FTD. For the NYBC cycle, NO_x reductions ranged from 19% to 22%, for an average reduction of 20%. For the UDDS cycle, the NO_x reduction was even greater, averaging 36%.

Results Summary—Total Hydrocarbons (THC)

All combinations of fuels and technologies produced dramatic changes in THC emissions. When the Purinox fuel was used without after-treatment, THC emissions increased substantially (1.a). Tests of Purinox with diesel oxidation catalysts showed significant reductions. However, after the catalyst was aged 1,000 hours, emissions increased to just above the baseline level (1.b). Table 2 shows the average reductions.

Table 2: THC Reduction Summary

Drive Cycle	1.a <i>Lubrizol Purinox vs. Std. Diesel</i>	1.b <i>Lubrizol Purinox & ECS Oxidation Catalyst</i>	2. <i>Johnson Matthey DPF</i>	3.a <i>Engelhard DPX PM Filter before reflash</i>	3.b <i>Engelhard DPX PM Filter after reflash</i>	4. <i>Alliance Longview</i>	5. <i>Engelhard DPX PM Filter and NOx Catalyst</i>	6. <i>Alliance Longview w/ NOx Catalyst and PM Filter</i>
NYBC	+75%	+7%	-93%	-100%	-100%	-94%	-100%	-100%
UDDS	+69%	+9%	-94%	-99%	-100%	-94%	-100%	-99%

Report Organization

The project included six distinct technology evaluations, as shown in Tables 1 and 2. The results of these evaluations are presented in four sections:

1. Summary data
2. A representative snapshot of the PM, NOx, and THC results for each technology
3. Graphs by fuel type and hardware device applied, showing the changes in PM, NOx, and THC
4. Comprehensive test data

I. Project Description

Project Goals

On June 27, 2001, the California Energy Commission (Energy Commission) approved a Standard Agreement 500-00-038 with the Clean Air Technology Center for \$250,000 to provide technical support and emission testing for the evaluation of the Department of Transportation's (Caltrans') *Greening of the Fleet Program*. This project's original goal was to evaluate the effectiveness of NO_x emission reduction options for ozone benefits. The goal was later expanded to include hydrocarbon reduction assessment based on the Weekend Ozone Study² findings that hydrocarbon reductions provide significant ozone reductions, at times greater than NO_x controls, depending on the region. Although, state NO_x reduction policy has not changed, the Weekend Ozone Studies suggest that hydrocarbon reductions can be an important ozone mitigation strategy. Caltrans may consider the results of these studies in anticipating future ozone strategy amendments.

Overall, project results demonstrate that there are alternate diesel fuels and retrofit devices that can significantly reduce PM, THC, and NO_x in both public and private medium and heavy-duty truck fleets. Of course, because project results are based on tests conducted at one point in time, structured fleet demonstrations would be required to predict the long-term emission effects.

Fuels and Technologies Tested

The emission-reduction strategies that were investigated for this project include:

- **Fuel Options:**
 - Standard #2 Diesel (“CARB diesel”)
 - Lubrizol’s Purinox
 - Arco’s ECD-1 Diesel
 - Three Fischer-Tropsch Diesel products, including: MossGas Super, MossGas Premium, and Shell Equilon
- **Technology Options:**
 - Diesel soot filter (DSF) (Johnson Matthey, Engelhard, and Cleaire)
 - Oxidation catalysts and traps (Johnson Matthey, Engelhard, Cleaire, and ECS)
 - Low NO_x Engine Recalibration (Reflash) with Diesel Soot Filter, Lubrizol Engine Control System

Six different fuel-technology combinations were evaluated. These test scenarios are detailed in Table 3.

Table 3: Fuel-Technology Combinations

Scenario	Fuel	Technology	Vehicle
#1	Lubrizol's Purinox Standard #2 Diesel	None ECS Diesel Oxidation Catalysts	1994 Dump truck w/ International DT466 engine
#2	Arco ECD-1 MossGas Premium Shell/Equilon Standard #2 Diesel	Johnson Matthey DPF	1999 Stake side dump truck w/ International DT466E engine
#3	Arco ECD-1 MossGas Premium Shell/Equilon	Engelhard DPX (particulate Filter)	2001 International 4900 dump truck w/ Navistar 8.7L engine
#4	MossGas Premium MossGas Super Shell/Equilon Standard #2 Diesel	None Cleaire Alliance Longview catalyst	1994 International 4900 dump truck w/ Navistar 8.7L engine
#5	Arco ECD-1 MossGas Super MossGas C Shell/Equilon Standard #2 Diesel	Engelhard DPX (particulate Filter) and catalyst	2001 International 4900 dump truck w/ International 530 engine
#6	Arco ECD-1 MossGas Super Shell/Equilon Standard #2 Diesel	None Cleaire Alliance Longview catalyst	1997 Freightliner Century Class tractor

Vehicles Tested and Performance Results

During the testing period, no significant performance losses or gains were associated with the technologies being evaluated. Likewise, no significant problems occurred with any of the vehicles' ability to follow the trace, and no noticeable problems arose when operating with the different fuels and/or NO_x and PM reduction devices.

Table 4 describes the vehicles used in each of the tests detailed in this report.

Table 4: Vehicles Tested

Technology	Vehicle Model	GVWR	Mileage
1. Purinox vs. Diesel	1994 Dump truck w/ International DT466 engine	24,990 lb.	29,885
2. Johnson Matthey DPF	1999 Stake side dump truck w/ International DT466E engine	22,340 lb.	5,032
3. Engelhard DPX (before and after reflash)	2001 International 4900 dump truck w/ Navistar 8.7L engine	25,550 lb.	673
4. Alliance Longview catalyst	1994 International 4900 dump truck w/ Navistar 8.7L engine	39,950 lb.	29,525
5. Cleaire oxidation catalyst	2001 International 4900 dump truck w/ International 530 engine	56,325 lb.	8,396
6. Cleaire catalyst	1997 Freightliner Century Class tractor	56,300 lb.	Odometer broken

Emission Testing Protocol

Project tests incorporated ARB's Retrofit Verification Procedures, which use transient test cycles. In addition, the Energy Commission added idle and steady-state test sequences. The test protocol used for each vehicle and emission reduction option specified in the test plan are as follows:

- One "Cold-Start" UDDS test –18 minutes cycle time and covers 5.51 miles

- Three “Hot-Start” UDDS tests – 18 minutes cycle time and covers 5.51 miles
- Three “Hot-Start” NYBC tests – 10 minutes cycle time and covers 0.57 miles
- One “Hot-Start/Stabilized” Idle test – cycle time is 6 minutes
- Two “Hot-Start/Stabilized” steady state tests – cycle time is 6 minutes and covers 5.96 miles

This protocol was used for all “Baseline” tests that use standard diesel, as well as all tests involving alternative fuels and retrofit technologies, although the sequencing of these tests varied.

The “Hot-Start” UDDS test followed the “Cold-Start” UDDS. The Cold-Start UDDS cycle was later dropped by ARB staff. The difference in the cycles is significant. A “hot start” test begins the cycle by first warming up the vehicle for about 10 minutes, while a “cold-start” test starts off at the ambient temperature and eventually builds up to the normal driving environment. The “cold-start” test is always the first test of the day and prior to its start, the vehicle is soaked/stabilized for 10-12 hours. The difference between the warmed/stabilized environment and a cold-start environment is significant.

III. Test Results

The following sections summarize test results for each of the six technology-fuel combinations.

Combination #1a – 1b —Lubrizol’s Purinox and Lubrizol’s Engine Control System Diesel Oxidation Catalysts vs. Standard #2 Diesel

The emissions comparison between Lubrizol’s Purinox fuel and standard diesel provided very interesting results, as shown in Table 5. Lubrizol’s Purinox was tested in one vehicle at two different times, and with different test weights. Consequently, two different “Baselines” were recorded. The use of Purinox fuel alone resulted in significantly increased THC emissions. The Purinox with DOC was evaluated using a 100 hour “degreened” and a 1,000 hour “aged” catalyst. Only the aged results are presented. Note that the results are based on the NYBC. Results are in grams/mile (g/mile). Complete test data is provided in the data section of the report.

Table 5: Combination #1 Results

Test Fuel	PM	Redux	NO _x	Redux	THC	Redux
Chevron Diesel #2	1.296	n.a.	78.11	n.a.	1.32	n.a.
Purinox & DOC	0.454	65%	59.6	24%	1.42	(7%)
Chevron Diesel #2	0.884	n.a.	55.72	n.a.	1.123	n.a.
Purinox (Fuel only)	0.475	46%	44.91	19%	1.965	+75%

Combination #2—Standard Diesel and Two FTD Fuels with a Johnson Matthey DPF

The emissions reductions associated with the FTD and Low Sulfur Diesel fuels with DPF vs. standard/baseline diesel are quite dramatic. The FTD emissions effects are summarized in Table 6 for the NYBC (g/mile):

Table 6: Combination #2 Results for the NYBC

Test Fuel	PM	Redux	NOx	Redux	THC	Redux
Chevron Diesel #2	0.610	n.a.	35.032	n.a.	0.701	n.a.
Arco ECD-1	0.061	90%	33.988	3%	0.015	98%
MossGas Premium	0.043	93%	32.281	8%	0.089	87%
Shell/Equilon	0.034	95%	30.629	13%	0.035	50%

The PM emission reductions for the UDDS cycle are similar to those for the NYBC shown in Table 6.

Combination #3—Standard Diesel vs. FTD Fuels with an Engelhard DPX Particulate Trap

For this technology, six test sequences were conducted. The test vehicle was equipped with an Engelhard DPX. The objective was to determine the effectiveness of using different fuels before and after the truck underwent a “reflash,” which involves modifying the truck’s engine calibration. Four fuels were evaluated on the test truck prior to reflashing; Standard #2 Diesel, Arco ECD-1, and MossGas, and Shell/Equilon FTD fuels. After the truck was “re-flashed,” it was retested with two fuels: Arco ECD-1 and Shell/Equilon FTD.

Sample data is provided in Table 7 based on the NYBC cycle.

Table 7: Combination #3 Results

Test Fuel	PM/Mi.	Redux	NO_x/Mi.	Redux	THC/Mi.	Redux
Chevron Diesel #2	0.593	n.a.	34.347	n.a	0.819	n.a
Arco ECD-1	0.011	98%	35.932	+ 5%	0.000	100%
MossGas - Premium	0.159	73%	31.911	7%	0.000	100%
Shell/Equilon	0.046	92%	36.261	+ 6%	0.000	100%
With reflash:						
Arco ECD-1	0.011	98%	29.419	14%	0.012	98%
Shell/Equilon	0.017	93%	26.555	23%	0.000	100%

Note that the test results prior to the reflash are not consistent, but do respond well after the reflash, for both the PM and NO_x.

Combination #4—Standard #2 Diesel vs. FTD Fuels with a Cleaire Alliance Longview Device Combining a NO_x Catalyst and a Particulate Matter Filter

This technology combination was tested using five standard sequences. The test vehicle used was the Caltrans International Dump Truck powered by a Navistar 8.7L engine. The baseline tests involved 3 Hot UDDS and 3 Hot NYBC tests using standard diesel. After the initial test sequence, the test vehicle was fitted with a Cleaire NO_x catalyst—the Alliance Longview—and run using the standard diesel. The last three sequences involved running the test vehicle with the Alliance Longview in conjunction with the three different FTD fuels. The objective was to determine the effectiveness of using the different fuels with and without the catalyst. As before, the focus was on reducing THC, NO_x, and PM.

The four fuels used for this project element were Standard #2 diesel: and the MossGas Super, MossGas, and Shell/Equilon FTDs.

Sample data is provided in Table 8 based on the NYBC cycle (g/mile).

Table 8: Combination #4 Results (NYBC Cycles)

Test Fuel	PM	Redux	NO_x	Redux	THC	Redux
Chevron Diesel #2 w/ Stock Muffler	1.167	n.a.	56.301	n.a	1.262	n.a
Chevron Diesel #2 w/Alliance LV	0.051	96%	47.663	15%	0.048	94%
MossGas Super w / Alliance LV	0.036	97%	42.093	25%	0.040	97%
MossGas Premium w / Alliance LV	0.041	96%	42.594	24%	0.024	98%

Shell/Equilon w/ Alliance	0.066	94%	41.704	26%	0.195	85%
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Note that the PM and NO_x emission reductions for the UDDS cycle are similar to those shown above.

Combination #5—Standard Diesel vs. FTD Fuels with an Engelhard DPX Particulate Filter and NO_x Catalyst

For this technology combination, the test vehicle was a 2001 International Dump Truck powered by a Navistar 8.7L engine. Five standard test sequences were performed. The three FTD fuels and the Ultra-Low Sulfur Diesel fuel were run first. For these first four test sequences, the test unit had the Engelhard Diesel Particulate Filter/Catalyst installed. Each different fuel was tested following the standard test protocol noted above: 3 Hot UDDS and 3 Hot NYBC tests, an Idle and a Steady State test sequence. After the initial four-test sequence, the test vehicle's Diesel Particulate Filter/Catalyst was removed. The fifth test sequence was run using the standard diesel fuel and no catalyst. The objective was to determine the effectiveness of using alternate diesel, in conjunction with the DSF, including the Ultra-Low Sulfur Diesel.

Sample data is provided in Table 9 based on the NYBC cycle.

Table 9: Combination #5 Results (NYBC Cycle)

Test Fuel	PM/Mi.	Redux	NOx/Mi.	Redux	THC/Mi.	Redux
Chevron Diesel #2 No Catalyst	1.007	n.a.	26.576	n.a	0.483	n.a
Arco ECD-1 w/ Catalyst	0.000	100%	25.572	4%	0.000	100%
MossGas Super w / Alliance LV	0.034	97%	25.731	3%	0.000	100%
MossGas Premium w / Alliance LV	0.000	100%	24.996	6%	0.000	100%
Shell/Equilon w/ Alliance	0.062	94%	25.191	5%	0.000	100%

Note that the PM and NO_x emission reductions for the UDDS cycle are similar to those shown above. The low NO_x reductions were unexpected since a NO_x catalyst was in place.

Technology #6—Standard Diesel vs. FTD Fuels with a Cleaire Alliance Longview Combining a NO_x Catalyst and a Particulate Filter

For this technology combination, the test vehicle was a 1997 Freightliner Tractor with a Century Class engine. Five standard test sequences were performed. Both standard test sequences were performed. Standard Diesel, TFD fuels, and Ultra-Low Sulfur Diesel fuels were used in this test sequence. The first baseline test used standard diesel and no after-treatment. The second baseline test used standard diesel, and a Cleaire Alliance Longview Catalyst. The next three tests used the Cleaire Alliance Longview Catalyst, and three fuels: Arco Ultra Low Diesel, Shell-Equilon FTD, and Moss Gas Super FTD.

For each combination, the basic test protocol was used: 3 Hot UDDS tests and 3 Hot NYBC tests, plus an Idle and Steady State test sequence. The objective was to determine the effectiveness of non-standard diesel and diesel alternatives, in conjunction with the use of a catalyst.

Sample data is provided in Table 10 based on the NYBC cycle.

Table 10: Combination #6 Results (NYBC Cycle)

Test Fuel	PM/Mi.	Redux	NO_x/Mi.	Redux	THC/Mi.	Redux
Chevron Diesel #2, No Catalyst	0.964	n.a.	37.20	n.a	1.782	n.a
Chevron Diesel #2, w/ Cleaire Catalyst	0.055	96%	31.24	16%	0.000	100%
Shell/Equilon GTL w/ Cleaire Catalyst	0.084	91%	30.47	18%	0.000	100%
Arco ECD-1 Diesel w/ Cleaire Catalyst	0.037	96%	31.65	15%	0.000	100%
MossGas Super GTL w/ Cleaire Catalyst	0.000	100%	27.12	27%	0.000	100%

III. Complete Test Data

This section presents the results of the six technology evaluations in four sections:

1. Summary data
2. A representative snapshot of the PM, NO_x, and THC results for each technology
3. Graphs by fuel type and hardware device applied, showing the changes in PM, NO_x, and THC
4. Comprehensive test data

In the following section, “Arco Ultra-Low Sulfur Diesel” and “ECD-1”are two names used interchangeable for the same fuel

Technology #1—Lubrizol Purinox vs. Standard Diesel



PURINOX with ECS Diesel Oxidation Catalyst vs. Diesel Emission Summary

Aged Catalysts (1,000 hours) Evaluated

Test Type		PM	THC	CO	NOX	CO2
NYBC		-65%	7%	-69%	-24%	-8%
UDDS		-40%	9%	-73%	-28%	-1%

PURINOX with ECS Diesel Oxidation Catalyst vs. Diesel Emission Summary

Degreened Catalysts (100 hours) Evaluated

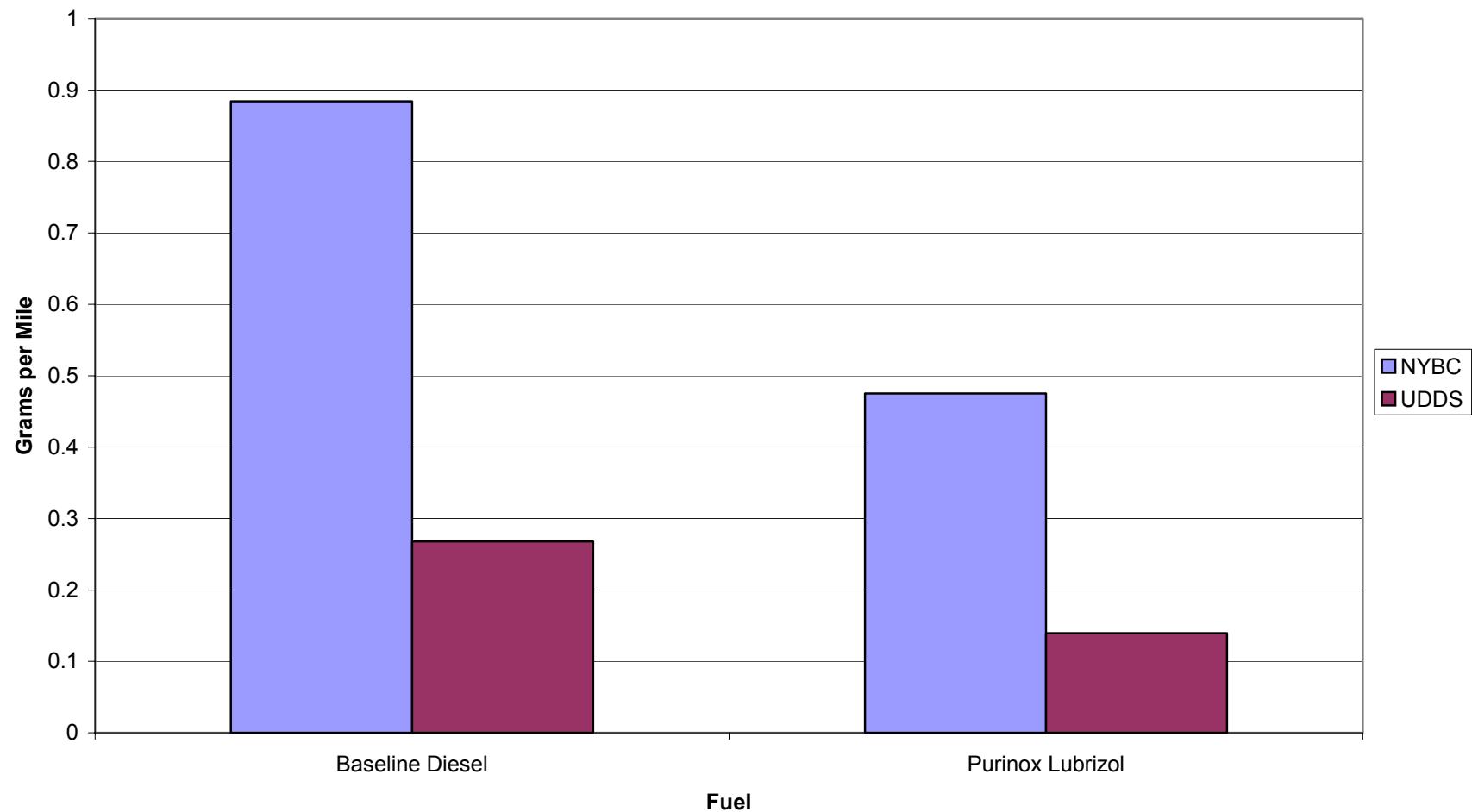
Test Type		PM	THC	CO	NOX	CO2
NYBC		-69%	-79%	-99%	-25%	-11%
UDDS		-65%	-76%	-97%	-28%	-3%

PURINOX with no ECS (Oxy Catalyst) vs. Diesel Emission Summary

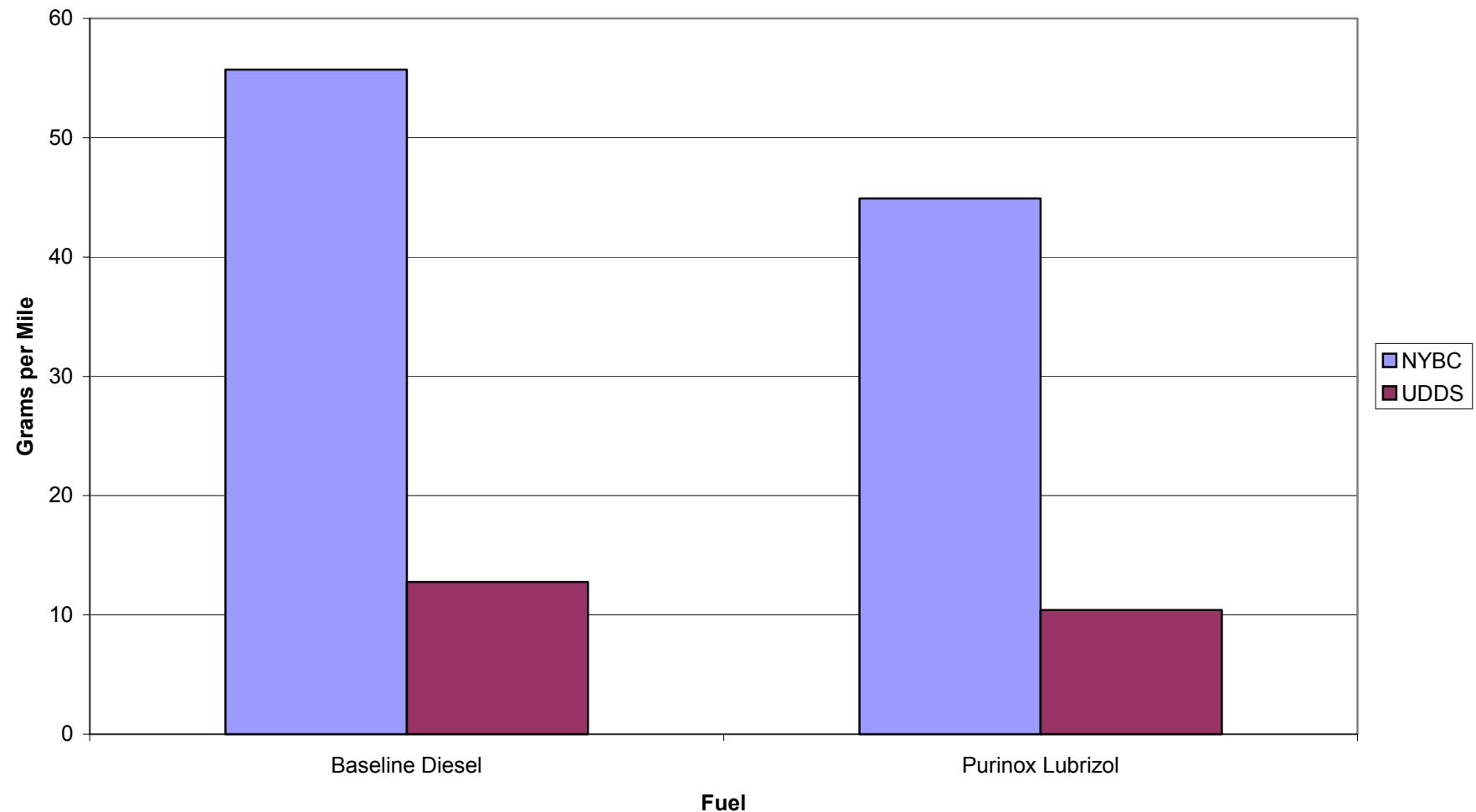
Note: - = Reduction, + = Increase

Test Type		PM	THC	CO	NOX	CO2	NMHC
NYBC		-46%	75%	-9%	-19%	-8%	76%
UDDS		-48%	69%	-2%	-18%	-2%	69%
Cold UDDS		-49%	65%	30%	-15%	-2%	64%
Hot Idle		-32%	123%	127%	-20%	2%	NA
SS @ 60 / 33.5KW		-46%	25%	9%	-11%	4%	25%
SS @ 60 / 49.5KW		-49%	45%	-1%	-16%	2%	45%

Technology #1
PM Effects of Lubrizol Purinox vs. Baseline Diesel
1994 Dump Truck w/ International DT466 Engine



Technology #1
NOx Effects of Purinox vs. Baseline Diesel
1994 Dump Truck w/ International DT466 Engine





Test Summary

Vehicle: CalTrans#6099 **Control#:** U01C_T01 **Date:** 8/6/2002
Truck Model
Year: 1994 **Test weight:** 11589 kg **Project:** Lubrizol
Model: International 4900 Dump **Dyno Coefficents:** A. 1998.251
Vin: 1HTSDAAN7RH585917 B. -69.63645
Engine: DT466 C. 1.770309
Engine Model
Year: 1993 D. -8.794554E-03

Test Fuel	Test Setup						
CARB D-2	OEM (no purimuffler)						
Micromotion							
Test #	Cycle	PM	THC	CO	NOX	CO₂	MPG
C0207034	NYBC	1.328	1.307	9.935	78.386	5583.625	1.840
C0207035	NYBC	1.248	1.334	9.499	76.330	5309.990	1.940
C0207036	NYBC	1.312	1.328	10.452	79.627	5543.482	1.840
	Average	1.296	1.323	9.962	78.114	5479.032	1.873
C0207030	HDDS	0.349	0.310	1.919	17.829	1698.535	5.950
C0207031	HDDS	0.385	0.318	2.038	18.642	1788.360	5.650
C0207033	HDDS	0.363	0.312	1.963	18.399	1772.031	5.670
	Average	0.366	0.313	1.973	18.290	1752.975	5.757

<i>Test Fuel</i>	<i>Test Setup</i>						
CARB D-2	with aged purimuffler installed			(Aged muffler = 1,000 hr)			
<i>Micromotion</i>							
<i>Test #</i>	<i>Cycle</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>MPG</i>
C0207057	NYBC	1.333	1.046	4.695	79.488	5606.664	1.790
C0207059	NYBC	1.053	0.444	4.597	76.323	5118.313	1.930
C0207061	NYBC	1.193	0.466	4.508	78.719	5567.731	1.810
	Average	1.193	0.652	4.600	78.177	5430.903	1.843
C0207062	HDDS	0.388	0.120	0.648	18.367	1801.710	5.570
C0207063	HDDS	0.407	0.132	0.671	18.313	1770.729	5.640
C0207064	HDDS	0.379	0.130	0.620	18.231	1742.570	5.700
	Average	0.391	0.127	0.647	18.304	1771.670	5.637

<i>Test Fuel</i>	<i>Test Setup</i>						
CARB D-2	with degreened purimuffler installed			(Degreened = 100 hr)			
<i>Micromotion</i>							
<i>Test #</i>	<i>Cycle</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>MPG</i>
C0207069	NYBC	1.139	0.067	0.260	74.332	5181.370	1.850
C0207070	NYBC	1.089	0.122	0.484	73.644	5095.808	1.940
C0207071	NYBC	1.096	0.073	0.443	74.328	5101.447	1.940
	Average	1.108	0.087	0.396	74.101	5126.208	1.910
C0207065	HDDS	0.383	0.007	0.023	18.090	1784.444	5.520
C0207066	HDDS	0.382	0.027	0.034	17.927	1759.248	5.620
C0207067	HDDS	0.388	0.026	0.031	18.209	1781.648	5.430
	Average	0.384	0.020	0.029	18.075	1775.113	5.523

<i>Test Fuel</i>	<i>Test Setup</i>						
PuriNOx	OEM (no purimuffler)						
<i>Test #</i>	<i>Cycle</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>MPG</i>
C0207037	NYBC	0.668	2.881	7.115	61.916	5241.871	1.630
C0207038	NYBC	0.679	3.026	7.336	60.204	5007.223	1.690
C0207039	NYBC	0.420	2.854	7.131	59.114	4837.722	1.780
C0207040	NYBC	0.692	2.879	6.998	59.909	5027.246	1.670
C0207041	NYBC	0.683	2.834	7.110	60.701	5019.212	1.670
	Average	0.628	2.895	7.138	60.369	5026.655	1.688
C0207042	HDDS	0.175	0.622	1.359	13.797	1773.831	4.740
C0207043	HDDS	0.162	0.612	1.385	13.604	1719.388	4.880
C0207044	HDDS	0.178	0.605	1.469	13.733	1768.118	4.780
C0207045	HDDS	0.175	0.640	1.477	13.409	1714.516	4.940
C0207046	HDDS	0.171	0.603	1.363	13.312	1672.572	5.030
	Average	0.172	0.615	1.423	13.515	1718.648	4.908

<i>Test Fuel</i>	<i>Test Setup</i>						
PuriNOx	with aged purimuffler installed						
<i>Test #</i>	<i>Cycle</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>MPG</i>
C0207052	NYBC	0.511	1.387	3.453	58.279	4901.662	1.700
C0207053	NYBC	0.457	1.364	2.996	60.336	5083.622	1.650
C0207054	NYBC	0.451	1.489	3.363	59.971	5072.315	1.650
C0207055	NYBC	0.442	1.423	2.615	59.687	5019.681	1.660
C0207056	NYBC	0.407	1.422	2.910	59.747	5015.053	1.670
	Average	0.454	1.417	3.067	59.604	5018.467	1.666

C0207047	HDDS	0.454	0.324	0.494	13.238	1710.846	4.830
C0207048	HDDS	0.285	0.328	0.461	13.163	1732.313	4.790
C0207049	HDDS	0.243	0.355	0.579	13.078	1735.730	4.790
C0207050	HDDS	0.188	0.344	0.550	13.267	1722.390	4.820
C0207051	HDDS	0.163	0.336	0.542	13.143	1730.672	4.830
	Average	0.220	0.341	0.533	13.163	1730.276	4.808

<i>Test Fuel</i>	<i>Test Setup</i>						
PuriNOx	with degreen purimuffler installed						
							<i>Micromotion</i>
<i>Test #</i>	<i>Cycle</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>MPG</i>
C0207073	NYBC	0.431	0.172	0.000	58.992	4885.671	1.730
C0207074	NYBC	0.425	0.533	0.669	58.483	4822.778	1.740
C0207075	NYBC	0.372	0.198	0.028	58.298	4885.916	1.720
C0207076	NYBC	0.414	0.236	0.000	59.559	4962.467	1.660
C0207077	NYBC	0.389	0.255	0.000	58.918	4800.724	1.740
	Average	0.406	0.279	0.139	58.850	4871.511	1.718
C0207078	HDDS	0.099	0.080	0.011	12.959	1612.700	5.160
C0207079	HDDS	0.176	0.069	0.039	13.038	1694.184	4.940
C0207080	HDDS	0.102	0.068	0.079	13.111	1706.204	4.860
C0207081	HDDS	0.123	0.081	0.044	13.233	1698.239	4.900
C0207083	HDDS	0.134	0.078	0.073	13.004	1693.293	4.920
	Average	0.127	0.074	0.059	13.097	1697.980	4.905

Vehicle: CalTrans # 6099
Model year: 1994
Engine: International DT466
Test weight: 11335kg

Date: 10/11/2001
Project: CEC
CVS flow rate: 3000cfm
Prepared by: Holly Haig-Ramage

Baseline Diesel										MPG
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	
C0110001	NYBC	Hot	0.853	1.129	5.480	57.722	4189.770	0.000	1.129	
C0110014	NYBC	Hot	0.887	1.153	5.229	54.681	4343.210	0.000	1.132	
C0110015	NYBC	Hot	0.913	1.088	5.540	54.749	4367.830	0.000	1.088	
	Average		0.884	1.123	5.416	55.717	4300.270	0.000	1.116	
	Std Dev.		0.030	0.033	0.165	1.736	96.484	0.000	0.024	
	Covariant		0.034	0.029	0.030	0.031	0.022	NA	0.022	
C0110004	Idle Grams	Hot	0.001	0.001	0.004	0.033	1.149	← <i>Idle in grams per second</i>		
C0110005	SS @ 60 / 33.5KW	Hot	0.205	0.209	0.938	5.904	1070.200	0.000	0.209	10.200
C0110036	SS @ 60 / 49.5KW	Hot	0.213	0.182	0.857	7.173	1245.510	0.000	0.183	8.400
C0110009	UDDS cold	Cold	0.354	0.339	1.649	13.349	1576.200	0.000	0.339	6.400
C0110010	UDDS	Hot	0.271	0.286	1.316	12.825	1395.510	0.000	0.286	7.300
C0110011	UDDS	Hot	0.277	0.295	1.343	12.789	1395.910	0.000	0.295	7.400
C0110012	UDDS	Hot	0.256	0.283	1.233	12.695	1360.200	0.000	0.283	7.500
	Average		0.268	0.288	1.297	12.770	1383.873	0.000	0.288	7.400
	Std Dev.		0.011	0.006	0.057	0.067	20.503	0.000	0.006	0.100
	Covariant		0.040	0.022	0.044	0.005	0.015	NA	0.022	0.014

Vehicle: CalTrans # 6099
Model year: 1994
Engine: International DT466
Test weight: 11335kg

Date: 10/11/2001
Project: CEC
CVS flow rate: 3000cfm
Prepared by: Holly Haig-Ramage

Lubrizol Purinox

Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG
C0110023	NYBC	Hot	0.471	1.939	5.472	45.124	4007.870	0.000	1.939	2.500
C0110024	NYBC	Hot	0.458	2.075	5.463	45.343	3970.520	0.000	2.075	2.600
C0110033	NYBC	Hot	0.497	1.881	3.849	44.272	3945.500	0.000	1.881	2.600
	Average		0.475	1.965	4.928	44.913	3974.630	0.000	1.965	2.567
	Std Dev.		0.020	0.100	0.934	0.566	31.387	0.000	0.100	0.058
	Covariant		0.042	0.051	0.190	0.013	0.008	NA	0.051	0.022
C0110020	Idle Grams	Hot	0.000	0.003	0.008	0.026	1.171	← <i>Idle in grams per second</i>		
C0110021	SS @ 60 / 33.5KW	Hot	0.110	0.262	1.019	5.259	1109.190	0.000	0.262	9.200
C0110022	SS @ 60 / 49.5KW	Hot	0.108	0.264	0.845	6.060	1273.310	0.000	0.264	7.900
C0110026	UDDS	Cold	0.181	0.558	2.150	11.392	1544.860	0.000	0.558	6.600
C0110027	UDDS	Hot	0.139	0.492	1.288	10.614	1362.250	0.000	0.492	7.500
C0110028	UDDS	Hot	0.136	0.479	1.268	10.371	1356.450	0.000	0.480	7.500
C0110030	UDDS	Hot	0.144	0.487	1.253	10.250	1359.790	0.000	0.487	7.500
	Average		0.140	0.486	1.270	10.412	1359.497	0.000	0.486	7.500
	Std Dev.		0.004	0.007	0.018	0.185	2.911	0.000	0.006	0.000
	Covariant		0.029	0.013	0.014	0.018	0.002	NA	0.013	0.000

Note: MPG changes are not accurate due to the difference in the fuels' energy content.

**Combination #2—Standard Diesel and Three FTD Fuels
in a HDV Equipped with a Johnson Matthey DPF**

Summary Data for the Effectiveness of the JohnsonMatthey DPF Using Various Fuels

(Test Results are Expressed as Gr./Mi. except for Idle Tests which are Expressed as Gr./Sec.)

Vehicle: CalTrans # 7547

Model year: 1999

Engine: International DT466E

Test weight: 10,133kg

Engine Family: DT466E HT

Mileage: 4,553 / 5,032

Vehicle Type: Stake side dump

Emissions ID#: YNVXH046ANA

Device: Johnson Matthey (DPF)

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	NYBC	Hot	0.610	0.701	10.984	35.032	4607.263	0.000	0.701	2.200
Arco Ultra Low Sulfur	NYBC	Hot	0.061	0.015	0.124	33.988	4648.707	0.000	0.000	2.167
% difference			-90%	-98%	-99%	-3%	1%		-100%	-2%
MossGas (GTL)	NYBC	Hot	0.043	0.089	0.135	32.281	4492.483	0.000	0.089	2.265
% difference			-93%	-87%	-99%	-8%	-2%		-87%	3%
Shell/Equilon	NYBC	Hot	0.034	0.035	0.028	30.629	4377.690	0.000	0.035	2.300
% difference			-94%	-95%	-100%	-13%	-5%		-95%	5%

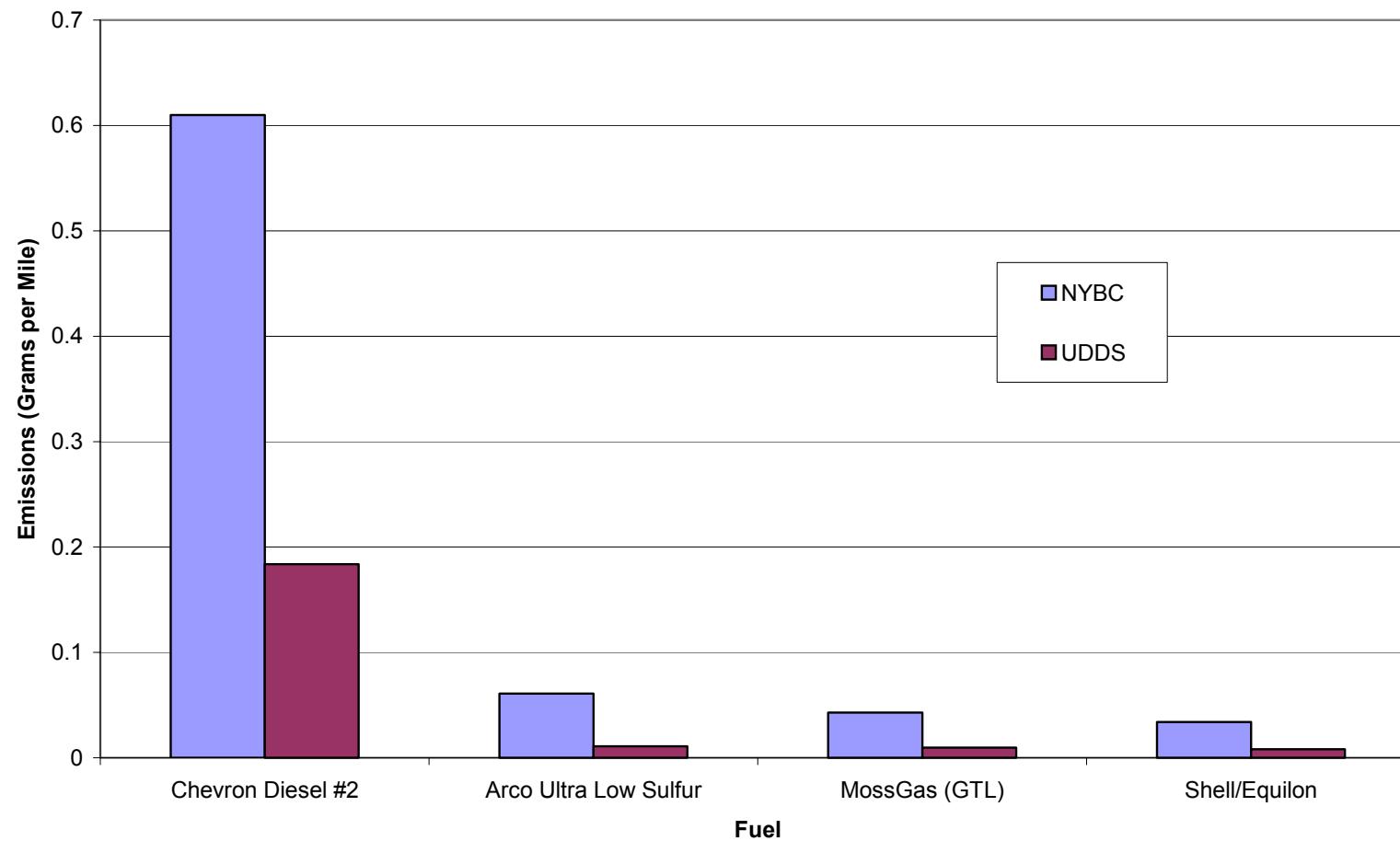
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	UDDS	Hot	0.184	0.201	3.009	11.302	1514.247	0.000	0.201	6.700
Arco Ultra Low Sulfur	UDDS	Hot	0.011	0.017	0.007	11.830	1552.810	0.000	0.017	6.567
% difference			-94%	-92%	-100%	5%	3%		-92%	-2%
MossGas (GTL)	UDDS	Hot	0.010	0.016	0.033	10.736	1473.970	0.000	0.016	6.904
% difference			-95%	-92%	-99%	-5%	-3%		-92%	3%
Shell/Equilon	UDDS	Hot	0.008	0.004	0.016	10.862	1479.003	0.000	0.004	6.867
% difference			-96%	-98%	-99%	-4%	-2%		-98%	2%

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	UDDS	Cold	0.224	0.221	2.985	13.056	1651.610	0.000	0.221	6.100
Arco Ultra Low Sulfur	UDDS	Cold	0.021	0.058	0.303	13.917	1725.070	0.000	0.059	5.900
% difference			-91%	-74%	-90%	7%	4%		-74%	-3%
MossGas (GTL)	UDDS	Cold	0.025	0.029	0.263	12.714	1625.380	0.000	0.029	6.259
% difference			-89%	-87%	-91%	-3%	-2%		-87%	3%
Shell/Equilon	UDDS	Cold	0.018	0.022	0.197	12.624	1614.010	0.000	0.022	6.300
% difference			-92%	-90%	-93%	-3%	-2%		-90%	3%

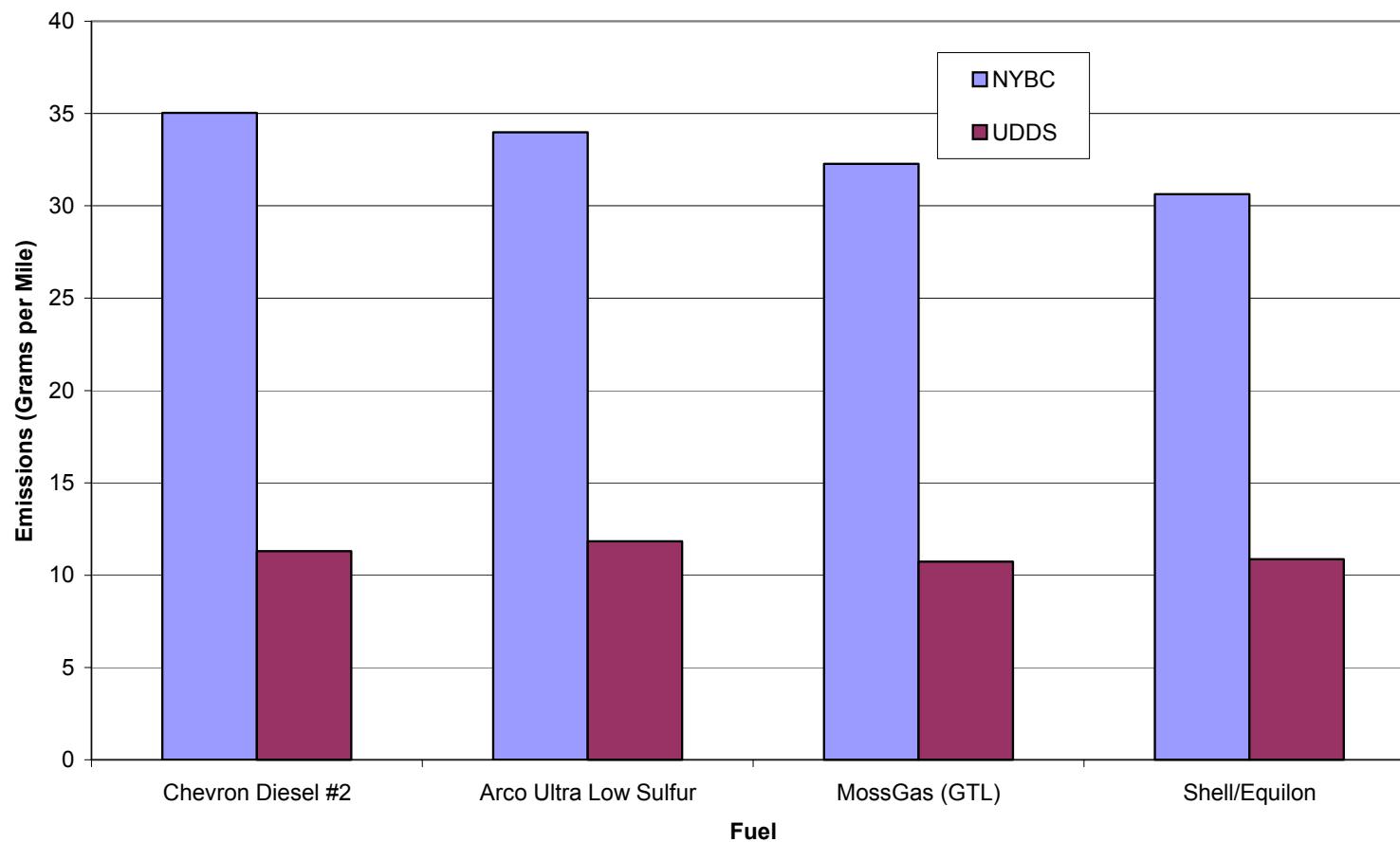
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	Idle Grams	Hot	0.00001	0.00083	0.00696	0.01340	1.34092	<-- Idle in grams per second		
Arco Ultra Low Sulfur	Idle Grams	Hot	0.00062	0.00057	0.00563	0.01517	1.38650	<-- Idle in grams per second		
% difference			4378%	-32%	-19%	13%	3%			
MossGas (GTL)	Idle Grams	Hot	0.00001	0.00054	0.00241	0.01237	1.27955	<-- Idle in grams per second		
% difference			0%	-35%	-65%	-8%	-5%			
Shell/Equilon	Idle Grams	Hot	0.00028	0.00017	0.00065	0.01099	1.32109	<-- Idle in grams per second		
% difference			1901%	-79%	-91%	-18%	-1%			

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	SS @ 60	Hot	0.067	0.102	1.015	6.932	1250.900	0.000	0.102	8.122
Arco Ultra Low Sulfur	SS @ 60	Hot	0.014	0.005	0.038	6.801	1299.020	0.000	0.005	7.800
% difference			-79%	-95%	-96%	-2%	4%		-95%	-4%
MossGas (GTL)	SS @ 60	Hot	0.011	0.003	0.027	6.080	1231.390	0.000	0.003	8.263
% difference			-84%	-97%	-97%	-12%	-2%		-97%	2%
Shell/Equilon	SS @ 60	Hot	0.013	0.002	0.007	6.001	1229.880	0.000	0.002	8.300
% difference			-81%	-98%	-99%	-13%	-2%		-98%	2%

Technology #2
PM Effect of Johnson Matthey DPF and Alternative Fuels
1999 Stake Side Dump Truck w/ International DT 466E



Technology #2
NOx Effect of Johnson Matthey DPF and Alternative Fuels
1999 Stake Side Dump Truck w/ International DT 466E



Vehicle: CalTrans # 7547

Model year: 1999

Engine: International DT466E

Test weight: 10,133kg

Engine Family: DT466E HT

Mileage: 4,553 / 5,032

Vehicle Type: Stake side dump

Emissions ID#: YNVXH046ANA

Device: Johnson Matthey (DPF)

RLMD: CT7547A → (A+Bv+Cv²+Dv³)

Date: 11/12/2001

Project: CEC

CVS flow rate: 1500cfm

Prepared by: Holly Haig-Ramage

Prepared for: CEC

A =	-434.88660
B =	30.55137
C =	-0.19648
D =	1.964838E-03

Diesel		Arco Ultra Low Sulfur											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%	
C0110053	NYBC	Hot	0.061	0.000	0.116	32.852	4527.470	0.000	0.000	2.200	69.53	51.63%	
C0110054	NYBC	Hot	0.070	0.000	0.188	34.803	4777.740	0.000	0.000	2.100	70.11	49.43%	
C0110055	NYBC	Hot	0.052	0.044	0.068	34.308	4640.910	0.000	0.000	2.200	70.96	47.26%	
	Average		0.061	0.015	0.124	33.988	4648.707	0.000	0.000	2.167	70.200	49.44%	
	Std Dev.		0.009	0.025	0.060	1.014	125.317	0.000	0.000	0.058	0.719	0.022	
	Covariant		0.148	1.732	0.487	0.030	0.027	#DIV/0!	#DIV/0!	0.027	0.010	0.044	
C0110058	Idle Grams	Hot	0.00062	0.00057	0.00563	0.01517	1.38650	← Idle in grams per second		71.77		48.66%	
C0110059	SS @ 60	Hot	0.014	0.005	0.038	6.801	1299.020	0.000	0.005	7.800	72	46.75%	
C0110065	UDDS cold	Cold	0.021	0.058	0.303	13.917	1725.070	0.000	0.059	5.900	69.96	52.27%	
C0110067	UDDS	Hot	0.011	0.014	0.000	11.885	1543.840	0.000	0.014	6.600	69.75	55.07%	
C0110068	UDDS	Hot	0.011	0.020	0.022	11.908	1572.430	0.000	0.020	6.500	70.57	50.96%	
C0110069	UDDS	Hot	0.011	0.016	0.000	11.697	1542.160	0.000	0.016	6.600	71.55	48.89%	
	Average		0.011	0.017	0.007	11.830	1552.810	0.000	0.017	6.567	70.623	51.64%	
	Std Dev.		0.000	0.003	0.013	0.116	17.012	0.000	0.003	0.058	0.901	0.031	
	Covariant		0.000	0.183	1.732	0.010	0.011	#DIV/0!	0.169	0.009	0.013	0.061	

Diesel	Shell / Equilon GTL											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%
C0110070	NYBC	Hot	0.042	0.045	0.015	30.994	4401.380	0.000	0.045	2.300	68.25	67.43%
C0110071	NYBC	Hot	0.034	0.037	0.069	30.653	4384.430	0.000	0.037	2.300	68.57	66.97%
C0110072	NYBC	Hot	0.025	0.022	0.000	30.240	4347.260	0.000	0.022	2.300	68.51	69.21%
	Average		0.034	0.035	0.028	30.629	4377.690	0.000	0.035	2.300	68.443	67.87%
	Std Dev.		0.009	0.012	0.036	0.378	27.682	0.000	0.012	0.000	0.170	0.012
	Covariant		0.253	0.337	1.296	0.012	0.006	#DIV/0!	0.346	0.000	0.002	0.017
C0110075	Idle Grams	Hot	0.00028	0.00017	0.00065	0.01099	1.32109	← Idle in grams per second		68.37	68.86%	
C0110076	SS @ 60	Hot	0.013	0.002	0.007	6.001	1229.880	0.000	0.002	8.300	67.33	69.59%
C0110077	UDDS	Cold	0.018	0.022	0.197	12.624	1614.010	0.000	0.022	6.300	69.22	61.12%
C0110078	UDDS	Hot	0.008	0.009	0.023	10.972	1491.620	0.000	0.009	6.800	69.07	60.55%
C0110079	UDDS	Hot	0.008	0.002	0.026	10.768	1471.830	0.000	0.002	6.900	69.56	58.85%
C0110080	UDDS	Hot	0.008	0.000	0.000	10.846	1473.560	0.000	0.000	6.900	70.42	56.61%
	Average		0.008	0.004	0.016	10.862	1479.003	0.000	0.004	6.867	69.683	58.67%
	Std Dev.		0.000	0.005	0.014	0.103	10.961	0.000	0.005	0.058	0.683	0.020
	Covariant		0.000	1.289	0.871	0.009	0.007	#DIV/0!	1.300	0.008	0.010	0.034

Diesel	MossGas GTL -- Diesel C											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0111001	NYBC	Hot	0.043	0.268	0.120	32.153	4499.650	0.000	0.268	2.261	67.5	59.42%
C0111002	NYBC	Hot	0.035	0.000	0.096	32.927	4556.870	0.000	0.000	2.233	68.07	59.36%
C0111003	NYBC	Hot	0.051	0.000	0.189	31.762	4420.930	0.000	0.000	2.302	71.17	53.78%
	Average		0.043	0.089	0.135	32.281	4492.483	0.000	0.089	2.265	68.913	0.575
	Std Dev.		0.008	0.155	0.048	0.593	68.253	0.000	0.155	0.035	1.975	0.032
	Covariant		0.186	1.732	0.358	0.018	0.015	#DIV/0!	1.732	0.015	0.029	0.056
C0111004	Idle Grams	Hot	0.00001	0.00054	0.00241	0.01237	1.27955	← Idle in grams per second			71.40	53.74%
C0111005	SS @ 60	Hot	0.011	0.003	0.027	6.080	1231.390	0.000	0.003	8.263	72.21	51.58%
C0111006	UDDS cold	Cold	0.025	0.029	0.263	12.714	1625.380	0.000	0.029	6.259	71.01	51.19%
C0111007	UDDS	Hot	0.010	0.000	0.022	10.882	1484.440	0.000	0.000	6.855	70.32	52.44%
C0111008	UDDS	Hot	0.010	0.027	0.029	10.763	1477.150	0.000	0.027	6.888	71.09	51.78%
C0111009	UDDS	Hot	0.009	0.020	0.049	10.563	1460.320	0.000	0.020	6.968	71.89	50.99%
	Average		0.010	0.016	0.033	10.736	1473.970	0.000	0.016	6.904	71.100	51.74%
	Std Dev.		0.001	0.014	0.014	0.161	12.370	0.000	0.014	0.058	0.785	0.007
	Covariant		0.060	0.894	0.420	0.015	0.008	#DIV/0!	0.890	0.008	0.011	0.014

Diesel	"Baseline" Chevron Diesel #2											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0111010	NYBC	Hot	0.656	0.648	11.472	35.990	4682.400	0.000	0.648	2.164	65.40	53.45%
C0111011	NYBC	Hot	0.576	0.733	10.602	34.789	4594.670	0.000	0.733	2.206	66.06	52.31%
C0111012	NYBC	Hot	0.598	0.723	10.878	34.318	4544.720	0.000	0.723	2.230	66.34	51.68%
	Average		0.610	0.701	10.984	35.032	4607.263	0.000	0.701	2.200	65.933	52%
	Std Dev.		0.041	0.046	0.445	0.862	69.699	0.000	0.046	0.033	0.483	0.009
	Covariant		0.068	0.066	0.040	0.025	0.015	#DIV/0!	0.066	0.015	0.007	0.017
C0111013	Idle Grams	Hot	0.00001	0.00083	0.00696	0.01340	1.34092	◀ Idle in grams per second				
C0111014	SS @ 60	Hot	0.067	0.102	1.015	6.932	1250.900	0.000	0.102	8.122	66.91	50%
C0111023	UDDS cold	Cold	0.224	0.221	2.985	13.056	1651.610	0.000	0.221	6.100	70.21	28.93%
C0111018	UDDS	Hot	0.185	0.199	3.195	11.347	1522.300	0.000	0.199	6.700	66.41	45.08%
C0111019	UDDS	Hot	0.184	0.197	2.993	11.414	1513.510	0.000	0.197	6.700	67.44	43.52%
C0111020	UDDS	Hot	0.182	0.207	2.838	11.145	1506.930	0.000	0.207	6.700	68.57	41.56%
	Average		0.184	0.201	3.009	11.302	1514.247	0.000	0.201	6.700	67.473	43%
	Std Dev.		0.002	0.005	0.179	0.140	7.711	0.000	0.005	0.000	1.080	0.018
	Covariant		0.008	0.026	0.059	0.012	0.005	#DIV/0!	0.027	0.000	0.016	0.041

**Combination #3—Standard Diesel vs. FTD Fuels with a
HDV Equipped with an Engelhard DPX Particulate Trap**

SUMMARY HDV TEST RESULTS & FUEL COMPARISONS

(Results in Gram/Mile, Except for Idle Test)

Vehicle: CalTrans#8711
Model year: 2001
Engine: Navistar 8.7L
Test weight: 11589kg

Vin# 1HTSDADN31H397699
Mileage: 673.00
Vehicle Type: Intrnl 4900 Dump
Emissions ID#: NA
Device: Engelhard DPX

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	NYBC	Hot	0.593	0.819	6.929	34.347	4370.089	0.000	0.819	2.343
Arco Ultra Low Sulfur	NYBC	Hot	0.011	0.000	0.000	35.932	4609.758	0.000	0.000	2.239
% difference			-98%	-100%	-100%	5%	5%		-100%	-4%
MossGas (GTL)	NYBC	Hot	0.159	0.000	0.202	31.911	4498.786	0.000	0.000	2.453
% difference			-73%	-100%	-97%	-7%	3%		-100%	5%
Shell/Equilon	NYBC	Hot	0.046	0.000	0.044	36.261	4492.264	0.000	0.000	2.280
% difference			-92%	-100%	-99%	6%	3%		-100%	-3%
Refash			Refash			Refash			Refash	
Shell/Equilon	NYBC	Hot	0.017	0.000	0.033	26.555	4773.852	0.000	0.000	2.132
% difference			-97%	-100%	-100%	-23%	9%		-100%	-9%
Arco Ultra Low Sulfur	NYBC	Hot	0.011	0.012	0.129	29.419	5124.475	0.000	0.012	1.987
% difference			-98%	-99%	-98%	-14%	17%		-99%	-15%

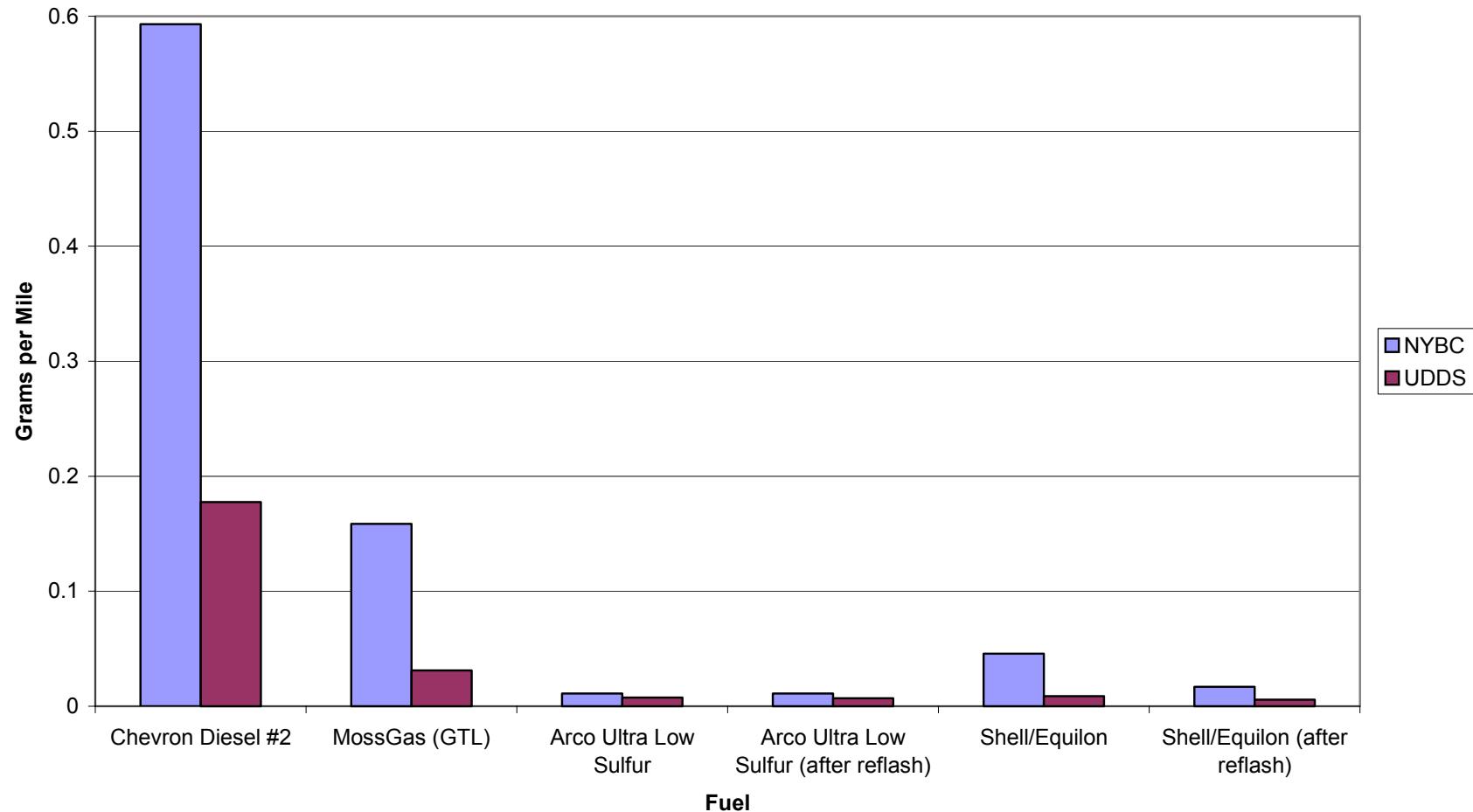
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	UDDS	Hot	0.178	0.201	1.960	13.664	1830.370	0.000	0.201	5.549
Arco Ultra Low Sulfur	UDDS	Hot	0.008	0.000	0.007	14.042	1873.617	0.000	0.000	5.431
% difference			-96%	-100%	-100%	3%	2%		-100%	-2%
MossGas (GTL)	UDDS	Hot	0.031	0.000	0.000	12.683	1815.003	0.000	0.000	5.607
% difference			-82%	-100%	-100%	-7%	-1%		-100%	1%
Shell/Equilon	UDDS	Hot	0.009	0.000	0.000	14.012	1881.907	0.000	0.003	5.409
% difference			-95%	-100%	-100%	3%	3%		-98%	-3%
Refash			Refash			Refash			Refash	
Shell/Equilon	UDDS	Hot	0.006	0.000	0.000	10.622	1869.387	0.000	0.000	5.444
% difference			-97%	-100%	-100%	-22%	2%		-100%	-2%
Arco Ultra Low Sulfur	UDDS	Hot	0.007	0.000	0.000	12.188	1897.834	0.000	0.000	5.363
% difference			-96%	-100%	-100%	-11%	4%		-100%	-3%

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	UDDS	Cold	0.225	0.213	2.276	14.875	1946.190	0.000	0.213	5.217
Arco Ultra Low Sulfur	UDDS	Cold	0.011	0.009	0.216	16.175	2049.129	0.000	0.009	4.965
% difference			-95 %	-96 %	-91 %	9 %	5 %		-96 %	-5 %
MossGas (GTL)	UDDS	Cold	0.011	0.013	0.244	15.277	1956.374	0.000	0.013	5.200
% difference			-95 %	-94 %	-89 %	3 %	1 %		-94 %	0 %
Shell/Equilon	UDDS	Cold	0.013	0.007	0.209	14.596	1982.805	0.000	0.007	5.131
% difference			-94 %	-97 %	-91 %	-2 %	2 %		-97 %	-2 %
					Reflash					
Shell/Equilon	UDDS	Cold	0.008	0.000	0.082	12.263	1984.370	0.000	0.000	5.128
% difference			-97 %	-100 %	-96 %	-18 %	2 %		-100 %	-2 %
Arco Ultra Low Sulfur	UDDS	Cold	0.006	0.038	0.318	13.598	2040.881	0.000	0.038	4.984
% difference			-97 %	-82 %	-86 %	-9 %	5 %		-82 %	-4 %

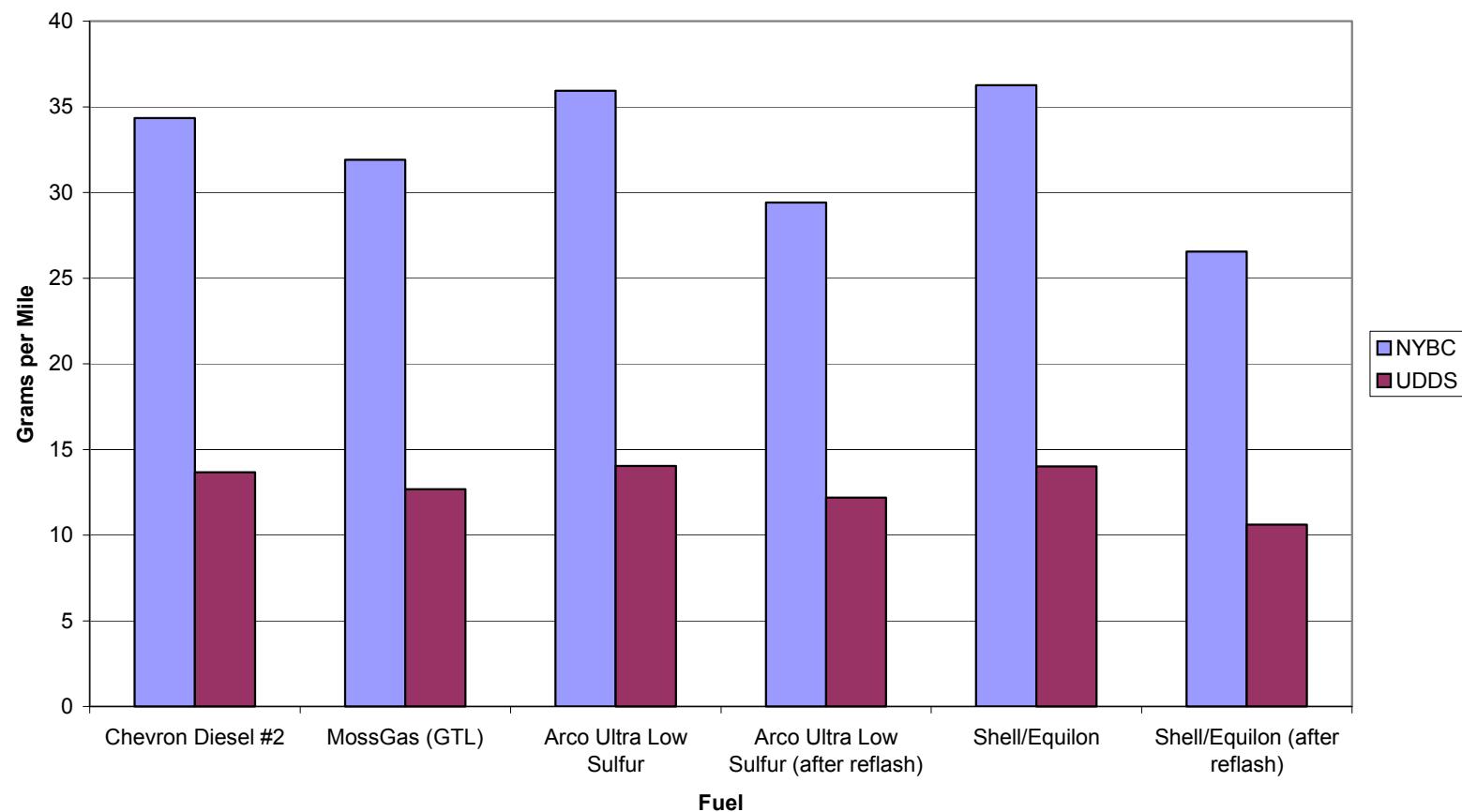
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	Idle Grams	Hot	0.00137	0.00000	0.00380	0.01515	1.29754	<-- Idle in grams per second		
Arco Ultra Low Sulfur	Idle Grams	Hot	0.00000	0.00000	0.00029	0.01458	1.48490	<-- Idle in grams per second		
% difference			-100 %		-92 %	-4 %	14 %			
MossGas (GTL)	Idle Grams	Hot	0.00000	0.00000	0.00007	0.01363	1.41459	<-- Idle in grams per second		
% difference			-100 %		-98 %	-10 %	9 %			
Shell/Equilon	Idle Grams	Hot	0.00000	0.00000	0.00019	0.00965	1.21482	<-- Idle in grams per second		
% difference			-100 %		-95 %	-36 %	-6 %			
					Reflash					
Shell/Equilon	Idle Grams	Hot	0.000	0.000	0.001	0.011	1.311	<-- Idle in grams per second		
% difference			-98 %		-79 %	-30 %	1 %			
Arco Ultra Low Sulfur	Idle Grams	Hot	0.000	0.000	0.001	0.014	1.312	<-- Idle in grams per second		
% difference			-98 %		-78 %	-8 %	1 %			

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG
Chevron Diesel #2	SS @ 60	Hot	0.177	0.058	1.416	11.700	2085.691	0.000	0.058	4.873
Arco Ultra Low Sulfur	SS @ 60	Hot	0.035	0.000	0.008	11.752	2115.265	NA	0.000	4.811
% difference			-80 %	-100 %	-99 %	0 %	1 %		-100 %	-1 %
MossGas (GTL)	SS @ 60	Hot	0.021	0.002	0.013	10.169	1969.681	0.000	0.002	5.166
% difference			-88 %	-96 %	-99 %	-13 %	-6 %		-96 %	6 %
Shell/Equilon	SS @ 60	Hot	0.079	0.000	0.014	11.764	2050.903	NA	0.000	4.962
% difference			-55 %	-100 %	-99 %	1 %	-2 %		-100 %	2 %
					Reflash					
Shell/Equilon	SS @ 60	Hot	0.118	0.009	0.000	8.931	2112.776	0.000	0.009	4.816
% difference			-34 %	-84 %	-100 %	-24 %	1 %		-84 %	-1 %
Arco Ultra Low Sulfur	SS @ 60	Hot	0.131	0.016	0.000	9.044	2166.822	0.000	0.016	4.696
% difference			-26 %	-72 %	-100 %	-23 %	4 %		-72 %	-4 %

Technology #3
PM Effects of Engelhard DPX, Alternative Fuels and Selected Reflash
2001 International 4900 Dump Truck w/ Navistar 8.7L



Technology #3
NOx Effects of Engelhard DPX, Alternative Fuels and Selected Reflash
2001 International 4900 Dump Truck w/ Navistar 8.7L



Vehicle: CalTrans#8711
Model year: 2001
Engine: Navistar 8.7L
Test weight: 11589kg

Vin# 1HTSDADN31H397699
Mileage: 673.00
Vehicle Type: Intrnl 4900 Dump
Emissions ID#: NA
Device: Engelhard DPX

RLMD:		→	(A+Bv+Cv ² +Dv ³)
A =	-677.43590		
B =	75.72911		
C =	-0.59077		
D =	4.183195E-03		

Date: 04/02/02
Project: CEC
CVS flow rate: 3000cfm
Prepared by: Holly Haig-Ramage
Prepared for: CEC

Diesel	<i>Arco Ultra Low Sulfur</i>											
Test #	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG	Temp	RH%
C0203020	NYBC	Hot	0.017	0.000	0.000	36.807	4785.384	NA	0.000	2.216	64.57	61.27%
C0203024	NYBC	Hot	0.017	0.000	0.000	34.522	4563.621	NA	0.000	2.230	65.84	59.65%
C0203025	NYBC	Hot	0.000	0.000	0.000	36.468	4480.269	NA	0.000	2.271	65.39	63.51%
	Average		0.011	0.000	0.000	35.932	4609.758	#DIV/0!	0.000	2.239	65.267	61.48%
	Std Dev.		0.010	0.000	0.000	1.233	157.703	#DIV/0!	0.000	0.029	0.644	0.019
	Covariant		0.881	#DIV/0!	#DIV/0!	0.034	0.034	#DIV/0!	#DIV/0!	0.013	0.010	0.032
C0203030	Idle Grams	Hot	0.000	0.000	0.00029	0.01458	1.48490	◀ <i>Idle in grams per second</i>		66.06	59.97%	
C0203028	SS @ 60	Hot	0.035	0.000	0.008	11.752	2115.265	NA	0.000	4.811	65.64	60.58%
C0203012	UDDS cold	Cold	0.011	0.009	0.216	16.175	2049.129	NA	0.009	4.965	67.45	40.35%
C0203017	UDDS	Hot	0.013	0.000	0.020	14.273	1874.868	NA	0.000	5.427	66.98	42.54%
C0203018	UDDS	Hot	0.006	0.000	0.000	14.147	1880.744	NA	0.000	5.411	67.08	44.50%
C0203019	UDDS	Hot	0.004	0.000	0.000	13.705	1865.237	NA	0.000	5.456	66.9	44.12%
	Average		0.008	0.000	0.007	14.042	1873.617	#DIV/0!	0.000	5.431	66.987	43.72%
	Std Dev.		0.005	0.000	0.012	0.299	7.829	#DIV/0!	0.000	0.023	0.090	0.010
	Covariant		0.624	#DIV/0!	1.732	0.021	0.004	#DIV/0!	#DIV/0!	0.004	0.001	0.024

Shell / Equilon GTL													
GTL	Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%
	C0203036	NYBC	Hot	0.017	0.000	0.000	37.533	4844.520	NA	0.000	2.100	68.72	18.72%
	C0203037	NYBC	Hot	0.085	0.000	0.131	35.745	3996.365	NA	0.000	2.546	69.16	19.86%
	C0203040	NYBC	Hot	0.035	0.000	0.000	35.505	4635.908	NA	0.000	2.195	69.55	19.68%
	Average			0.046	0.000	0.044	36.261	4492.264	#DIV/0!	0.000	2.280	69.143	19.42%
	Std Dev.			0.036	0.000	0.076	1.108	441.947	#DIV/0!	0.000	0.235	0.415	0.006
	Covariant			0.778	#DIV/0!	1.732	0.031	0.098	#DIV/0!	#DIV/0!	0.103	0.006	0.032
	C0203038	Idle Grams	Hot	0.000	0.000	0.00019	0.00965	1.21482	◀ Idle in grams per second		69.7		21.30%
	C0203039	SS @ 60	Hot	0.079	0.000	0.014	11.764	2050.903	NA	0.000	4.962	69.04	21.77%
		UDDS	Cold	0.013	0.007	0.209	14.596	1982.805	NA	0.007	5.131	65.72	31.34%
	C0203033	UDDS	Hot	0.015	0.000	0.000	14.211	1920.142	NA	0.009	5.300	64.12	23.46%
	C0203034	UDDS	Hot	0.004	0.000	0.000	14.048	1847.615	NA	0.000	5.508	66.15	19.95%
	C0203035	UDDS	Hot	0.008	0.000	0.000	13.776	1877.963	NA	0.000	5.419	67.72	16.79%
	Average			0.009	0.000	0.000	14.012	1881.907	#DIV/0!	0.003	5.409	65.997	20.07%
	Std Dev.			0.006	0.000	0.000	0.220	36.424	#DIV/0!	0.005	0.104	1.805	0.033
	Covariant			0.655	#DIV/0!	#DIV/0!	0.016	0.019	#DIV/0!	1.732	0.019	0.027	0.166

GTL	MossGas GTL -- Diesel C											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0203055	NYBC	Hot	0.237	0.000	0.218	32.423	4550.599	0.000	0.000	2.236	60.38	26.74%
C0203056	NYBC	Hot	0.102	0.000	0.000	31.840	4451.568	0.000	0.000	2.860	61.32	24.61%
C0203057	NYBC	Hot	0.137	0.000	0.388	31.470	4494.191	0.000	0.000	2.264	62	23.65%
	Average		0.159	0.000	0.202	31.911	4498.786	0.000	0.000	2.453	61.233	0.250
	Std Dev.		0.070	0.000	0.195	0.480	49.676	0.000	0.000	0.352	0.813	0.016
	Covariant		0.440	#DIV/0!	0.963	0.015	0.011	#DIV/0!	#DIV/0!	0.144	0.013	0.063
C0203046	Idle Grams	Hot	0.000	0.000	0.00007	0.01363	1.41459	← Idle in grams per second			66.21	27.25%
C0203054	SS @ 60	Hot	0.021	0.002	0.013	10.169	1969.681	0.000	0.002	5.166	59.38	28.47%
C0203048	UDDS cold	Cold	0.011	0.013	0.244	15.277	1956.374	0.000	0.013	5.200	60.22	33.58%
C0203049	UDDS	Hot	0.073	0.000	0.000	12.671	1790.566	0.000	0.000	5.683	60.79	35.75%
C0203050	UDDS	Hot	0.009	0.000	0.000	12.419	1809.877	0.000	0.000	5.622	61.95	34.25%
C0203052	UDDS	Hot	0.011	0.000	0.000	12.960	1844.567	0.000	0.000	5.517	63.20	34.86%
	Average		0.031	0.000	0.000	12.683	1815.003	0.000	0.000	5.607	61.980	34.95%
	Std Dev.		0.036	0.000	0.000	0.271	27.363	0.000	0.000	0.084	1.205	0.008
	Covariant		1.159	1.732	#DIV/0!	0.021	0.015	#DIV/0!	1.732	0.015	0.019	0.022

Diesel	"Baseline" Chevron Diesel #2											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C020358	NYBC	Hot	0.649	0.804	6.750	34.905	4713.871	0.000	0.804	2.153	67.34	34.33%
C020359	NYBC	Hot	0.560	0.827	7.141	34.337	4598.067	0.000	0.827	2.206	67.54	27.90%
C020360	NYBC	Hot	0.570	0.827	6.897	33.799	3798.329	0.000	0.827	2.670	69.19	26.03%
	Average		0.593	0.819	6.929	34.347	4370.089	0.000	0.819	2.343	68.023	29%
	Std Dev.		0.049	0.013	0.197	0.553	498.532	0.000	0.013	0.284	1.015	0.044
	Covariant		0.082	0.016	0.028	0.016	0.114	#DIV/0!	0.016	0.121	0.015	0.148
C0203062	Idle Grams	Hot	0.001	0.000	0.00380	0.01515	1.29754	◀ Idle in grams per second		71.19		28.57%
C0203068	SS @ 60	Hot	0.177	0.058	1.416	11.700	2085.691	0.000	0.058	4.873	72.15	33.02%
C0203064	UDDS cold	Cold	0.225	0.213	2.276	14.875	1946.190	0.000	0.213	5.217	66.8	42.66%
C0203065	UDDS	Hot	0.185	0.222	2.114	13.444	1813.218	0.000	0.222	5.600	66.81	41.92%
C0203066	UDDS	Hot	0.171	0.198	1.863	13.937	1849.412	0.000	0.198	5.492	68.34	39.36%
C0203067	UDDS	Hot	0.177	0.184	1.903	13.610	1828.479	0.000	0.184	5.554	71.18	34.27%
	Average		0.178	0.201	1.960	13.664	1830.370	0.000	0.201	5.549	68.777	38.52%
	Std Dev.		0.007	0.019	0.135	0.251	18.171	0.000	0.019	0.054	2.217	0.039
	Covariant		0.038	0.095	0.069	0.018	0.010	#DIV/0!	0.095	0.010	0.032	0.101



Diesel	Arco Ultra Low Sulfur											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%
C0203087	NYBC	Hot	0.017	0.000	0.165	29.770	5314.536	0.000	0.000	1.915	64.24204	56.22%
C0203088	NYBC	Hot	0.017	0.000	0.118	30.209	5065.237	0.000	0.000	2.009	65.58083	54.78%
C0203090	NYBC	Hot	0.017	0.035	0.105	28.276	4993.653	0.000	0.035	2.038	66.97713	52.05%
	Average		0.011	0.012	0.129	29.419	5124.475	0.000	0.012	1.987	65.600	54.35%
	Std Dev.		0.000	0.020	0.031	1.013	168.444	0.000	0.020	0.064	1.368	0.021
	Covariant		0.005	1.732	0.243	0.034	0.033	#DIV/0!	1.732	0.032	0.021	0.039
C0203085	Idle Grams	Hot	0.0000	0.0004	0.00084	0.01400	1.31172	← Idle in grams per second			71.56	48.27%
C0203084	SS @ 60	Hot	0.131	0.016	0.000	9.044	2166.822	0.000	0.016	4.696	70.64401	49.72%
C0203080	UDDS cold	Cold	0.006	0.038	0.318	13.598	2040.881	0.000	0.038	5.0	65.25145	57.62%
C0203081	UDDS	Hot	0.006	0.000	0.000	12.307	1924.370	0.000	0.000	5.288	66.06696	55.92%
C0203082	UDDS	Hot	0.007	0.000	0.000	11.935	1909.148	0.000	0.000	5.330	67.8428	53.08%
C0203083	UDDS	Hot	0.007	0.000	0.000	12.321	1859.985	0.000	0.000	5.471	69.69356	50.32%
	Average		0.007	0.000	0.000	12.188	1897.834	0.000	0.000	5.363	67.868	53.11%
	Std Dev.		0.001	0.000	0.000	0.219	33.651	0.000	0.000	0.096	1.813	0.028
	Covariant		0.155	#DIV/0!	#DIV/0!	0.018	0.018	#DIV/0!	#DIV/0!	0.018	0.027	0.053

GTL	Shell / Equilon GTL											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%
C0203091	NYBC	Hot	0.017	0.000	0.032	27.097	4874.229	0.000	0.000	2.088	69.63314	47.81%
C0203092	NYBC	Hot	0.017	0.000	0.067	25.533	4665.662	0.000	0.000	2.181	70.67553	49.74%
C0203093	NYBC	Hot	0.017	0.000	0.000	27.036	4781.665	0.000	0.000	2.128	71.69538	48.18%
	Average		0.017	0.000	0.033	26.555	4773.852	0.000	0.000	2.132	70.668	48.58%
	Std Dev.		0.000	0.000	0.034	0.886	104.503	0.000	0.000	0.047	1.031	0.010
	Covariant		0.004	#DIV/0!	1.021	0.033	0.022	#DIV/0!	#DIV/0!	0.022	0.015	0.021
C0203095	Idle Grams	Hot	0.0000	0.0004	0.00079	0.01059	1.31081	← Idle in grams per second			75.51	38.72%
C0203094	SS @ 60	Hot	0.118	0.009	0.000	8.931	2112.776	0.000	0.009	4.816	74.183	42.89%
C0203098	UDDS	Cold	0.008	0.000	0.082	12.263	1984.370	0.000	0.000	5.128	64.55164	58.07%
C0203099	UDDS	Hot	0.000	0.000	0.000	10.409	1849.928	0.000	0.000	5.501	65.17572	58.51%
C0203100	UDDS	Hot	0.011	0.000	0.000	10.719	1884.787	0.000	0.000	5.399	69.22052	52.93%
C0203101	UDDS	Hot	0.006	0.000	0.000	10.738	1873.446	0.000	0.000	5.432	71.53199	48.50%
	Average		0.006	0.000	0.000	10.622	1869.387	0.000	0.000	5.444	68.643	53.31%
	Std Dev.		0.006	0.000	0.000	0.184	17.780	0.000	0.000	0.052	3.217	0.050
	Covariant		0.976	#DIV/0!	#DIV/0!	0.017	0.010	#DIV/0!	#DIV/0!	0.010	0.047	0.094

Technology #4—Standard Diesel vs. FTD Fuels with a HDV Equipped with a Cleaire Alliance Longview which combines a NO_x Catalyst and a Particulate Filter

SUMMARY HDV TEST RESULTS & FUEL COMPARISONS

(Results in Gram/Mile, Except for Idle Test)

Vehicle: CalTrans#6100
Model year: 1994
Engine: Navistar 8.7L
Test weight: 18121kg

Vin #: 1HTSDAAN7RH585903
Mileage: 38,000
Vehicle Type: Intri 4900 Dump
Emissions ID#: NA
Device: Alliance LV

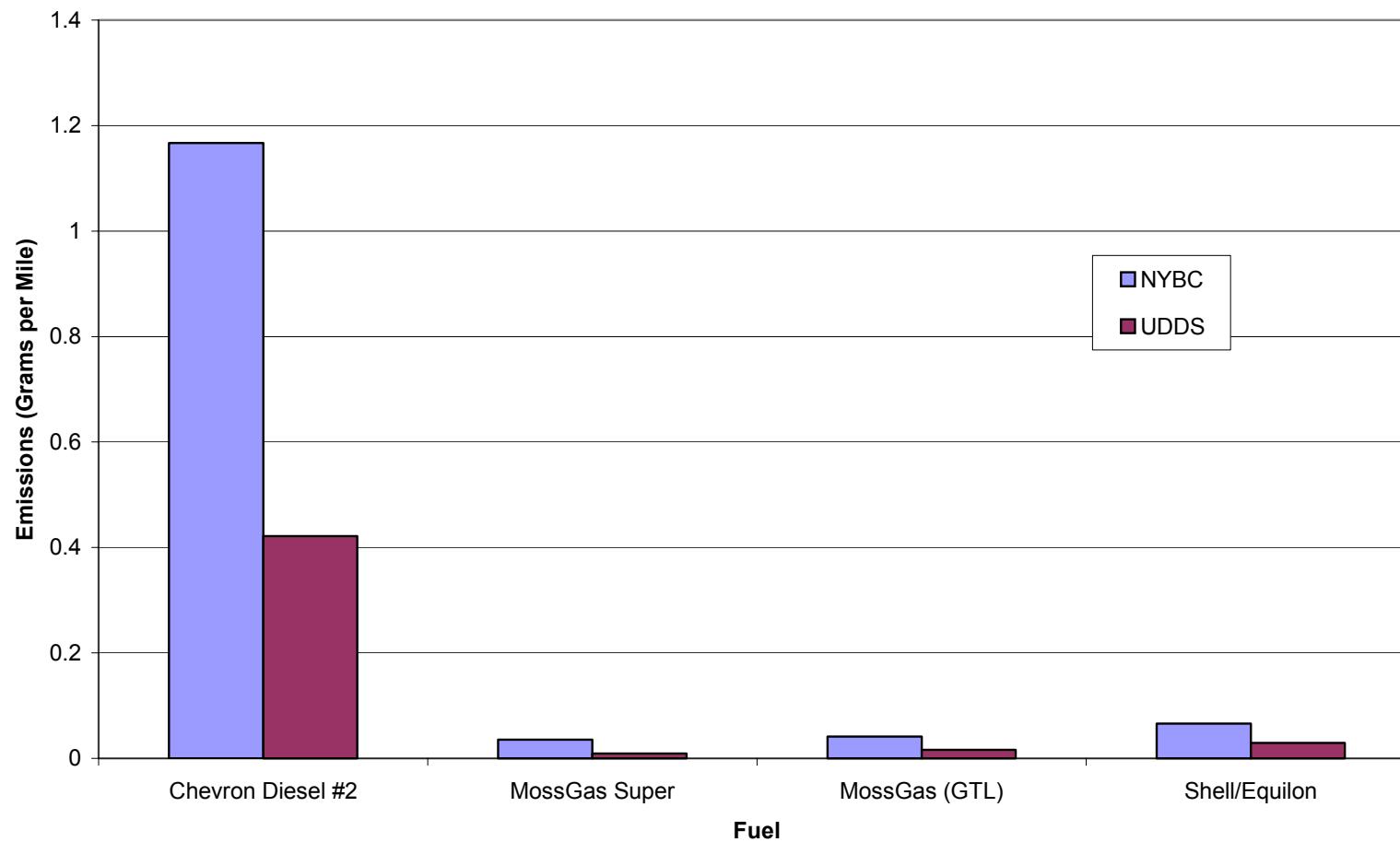
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG
Baseline No Device	NYBC	Hot	1.167	1.262	10.518	56.301	4606.12	NA	NA	2.20
Chev. Diesel #2 w/Alliance	NYBC	Hot	0.051	0.048	0.060	47.663	4753.80	NA	NA	2.14
% difference			-96%	-96%	-99%	-15%	3%			-3%
MossGas Super w/Alliance	NYBC	Hot	0.036	0.040	0.091	42.093	4434.62	NA	NA	2.26
% difference			-97%	-97%	-99%	-25%	-4%			3%
MossGas (GTL) w/Alliance	NYBC	Hot	0.041	0.024	0.001	42.594	4512.48	NA	NA	2.26
% difference			-96%	-98%	-100%	-24%	-2%			2%
Shell/Equilon w/Alliance	NYBC	Hot	0.066	0.195	0.032	41.704	4526.81	NA	NA	2.25
% difference			-94%	-85%	-100%	-26%	-2%			2%

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG
Baseline No Device	UDDS	Hot	0.422	0.308	2.258	15.901	1969.90	NA	NA	5.16
Chev. Diesel #2 w/Alliance	UDDS	Hot	0.050	0.016	0.014	11.348	2090.80	NA	NA	4.87
% difference			-88%	-95%	-99%	-29%	6%			-6%
MossGas Super w/Alliance	UDDS	Hot	0.009	0.017	0.013	9.413	2036.27	NA	NA	5.00
% difference			-98%	-95%	-99%	-41%	3%			-3%
MossGas (GTL) w/Alliance	UDDS	Hot	0.016	0.011	0.015	9.343	2013.60	NA	NA	5.05
% difference			-96%	-96%	-99%	-41%	2%			-2%
Shell/Equilon w/Alliance	UDDS	Hot	0.030	0.033	0.000	9.270	2016.76	NA	NA	5.05
% difference			-93%	-89%	-100%	-42%	2%			-2%

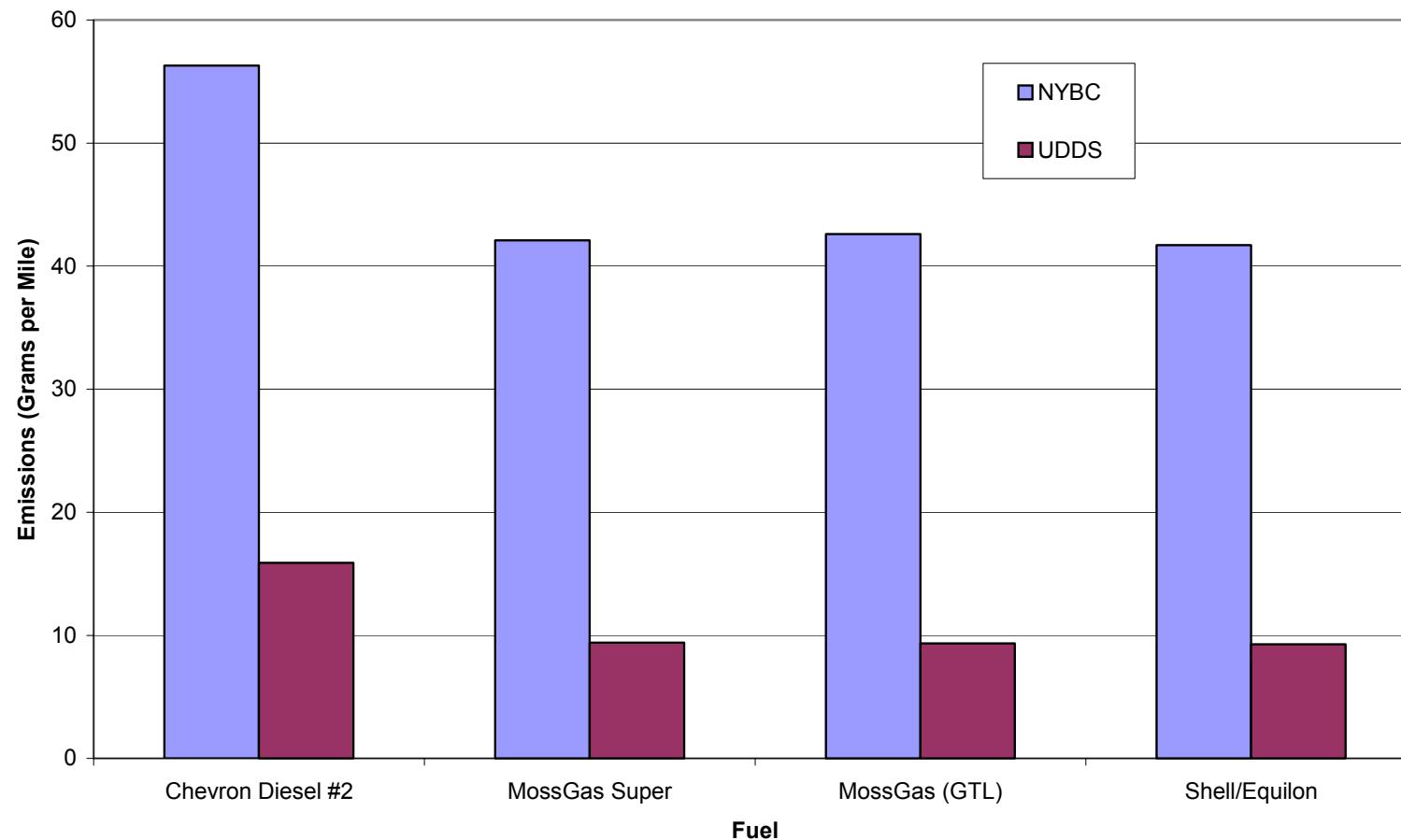
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG
Baseline No Device	Idle Grams	Hot	0.0001	0.0002	0.007	0.032	1.25	<-- Idle in grams per second		
Chev. Diesel #2 w/Alliance	Idle Grams	Hot	0.0001	0.0002	0.000	0.030	1.14	<-- Idle in grams per second		
% difference			42%	-4%	-100%	-6%	-9%			
MossGas Super w/Alliance	Idle Grams	Hot	0.000	0.001	0.001	0.030	1.34	<-- Idle in grams per second		
% difference			-100%	443%	-91%	-7%	7%			
MossGas (GTL) w/Alliance	Idle Grams	Hot	0.000	0.000	0.000	0.028	1.20	<-- Idle in grams per second		
% difference			-100%	-100%	-100%	-13%	-4%			
Shell/Equilon w/Alliance	Idle Grams	Hot	0.000	0.000	0.000	0.023	1.20	<-- Idle in grams per second		
% difference			-41%	-100%	-100%	-27%	-4%			

Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG
Baseline No Device	SS @ 60	Hot	0.472	0.177	1.730	12.507	2217.70	NA	NA	4.58
Chev. Diesel #2 w/Alliance	SS @ 60	Hot	0.427	0.166	1.617	11.802	2097.80	NA	NA	4.84
% difference			-10%	-6%	-7%	-6%	-5%			6%
MossGas Super w/Alliance	SS @ 60	Hot	0.065	0.051	0.000	6.243	2252.28	NA	NA	4.52
% difference			-86%	-71%	-100%	-50%	2%			-1%
MossGas (GTL) w/Alliance	SS @ 60	Hot	0.118	0.048	0.000	6.417	2223.89	NA	NA	4.58
% difference			-75%	-73%	-100%	-4.9%	0%			0%
Shell/Equilon w/Alliance	SS @ 60	Hot	0.099	0.041	0.000	6.185	2221.69	NA	NA	4.58
% difference			-79%	-77%	-100%	-51%	0%			0%

Technology #4
PM Effects of Cleaire Alliance Longview Catalyst and Alternative Fuels
1994 International 4900 Dump Truck w/ Navistar 8.7L



Technology #4
NOx Effects of Cleaire Alliance Longview Catalyst and Alternative Fuels
1994 International 4900 Dump Truck w/ Navistar 8.7L



Vehicle: CalTrans#6100
Model year: 1994
Engine: Navistar 8.7L
Test weight: 18121kg

Vin# 1HTSDAAN7RH585903

Mileage:
Vehicle Type: Intrnl 4900 Dump
Emissions ID#: NA
Device: Alliance LV

RLMD: → (A+Bv+Cv²+Dv³)

Vehicle	Road
A. -465.322	-677.43590
B. 92.4284	75.72911
C. -7.483884	-0.59077
D. 4.557332E-03	4.183195E-03

Date: 07/10/02

Project: CEC

CVS flow rate: 3000cfm

Prepared by: Holly Haig-Ramage

Prepared for: CEC

Diesel MossGass Super w/Alliance Longview												
Test #	Cycle	Type	PM	THC	CO	NOX	CO₂	CH4	NMHC	MPG	Temp	RH%
C0206087	NYBC	Hot	0.000	0.027	0.233	41.886	4375.731	NA	0.027	2.230	70.6923	48.93%
C0206088	NYBC	Hot	0.053	0.029	0.040	42.178	4453.142	NA	0.029	2.285	71.6116	48.89%
C0206089	NYBC	Hot	0.054	0.066	0.000	42.215	4474.974	NA	0.066	2.274	71.81864	48.12%
	Average		0.036	0.040	0.091	42.093	4434.616	NA	0.040	2.263	71.374	48.65%
	Std Dev.		0.031	0.022	0.124	0.180	52.151	NA	0.022	0.029	0.600	0.005
	Covariant		0.866	0.540	1.365	0.004	0.012	NA	0.540	0.013	0.008	0.009
C0206082	Idle Grams	Hot	0.0000	0.3886	0.00060	0.02963	1.34395	← Idle in grams per second		66.6480		55.41%
C0206079	SS @ 60	Hot	0.065	0.051	0.000	6.243	2252.280	NA	0.051	4.518	67.44421	52.54%
C0206083	UDDS	Hot	0.009	0.017	0.000	9.661	2035.466	NA	0.017	4.999	68.3078	51.92%
C0206084	UDDS	Hot	0.007	0.017	0.025	9.280	2033.669	NA	0.017	5.004	69.1690	51.13%
C0206085	UDDS	Hot	0.011	0.017	0.013	9.297	2039.684	NA	0.017	4.989	70.1405	49.73%
	Average		0.009	0.017	0.013	9.413	2036.273	NA	0.017	4.997	69.206	50.93%
	Std Dev.		0.002	0.000	0.013	0.215	3.088	NA	0.000	0.008	0.917	0.011
	Covariant		0.202	0.011	0.988	0.023	0.002	NA	0.011	0.002	0.013	0.022

Diesel	Shell / Equilon GTL w/Alliance Longview											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	CH4	NMHC	MPG	Temp	RH%
C0206061	NYBC	Hot	0.071	0.000	0.097	42.923	4574.769	NA	0.000	2.224	76.40083	40.95%
C0206062	NYBC	Hot	0.072	0.444	0.000	40.412	4446.431	NA	0.444	2.288	78.3447	32.64%
C0206064	NYBC	Hot	0.054	0.140	0.000	41.776	4559.236	NA	0.140	2.232	75.49956	50.96%
	Average		0.066	0.195	0.032	41.704	4526.812	NA	0.195	2.248	76.748	41.52%
	Std Dev.		0.010	0.227	0.056	1.257	70.044	NA	0.227	0.035	1.454	0.092
	Covariant		0.150	1.167	1.732	0.030	0.015	NA	1.167	0.016	0.019	0.221
C0206060	Idle Grams	Hot	0.0001	0.0000	0.00000	0.02338	1.20458	← Idle in grams per second			75.59536	43.29%
C0206059	SS @ 60	Hot	0.099	0.041	0.000	6.185	2221.689	NA	0.041	4.580	73.7668	44.57%
C0206065	UDDS	Hot	0.026	0.030	0.000	9.172	2006.590	NA	0.030	5.071	76.1000	49.94%
C0206067	UDDS	Hot	0.028	0.059	0.000	9.411	2026.619	NA	0.059	5.021	78.0466	47.00%
C0206068	UDDS	Hot	0.034	0.008	0.000	9.225	2017.075	NA	0.008	5.045	79.5536	44.88%
	Average		0.030	0.033	0.000	9.270	2016.761	NA	0.033	5.046	77.900	47.27%
	Std Dev.		0.004	0.025	0.000	0.126	10.018	NA	0.025	0.025	1.731	0.025
	Covariant		0.130	0.779	0.000	0.014	0.005	NA	0.779	0.005	0.022	0.054

Diesel	MossGas GTL w/Alliance Longview											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0206073	NYBC	Hot	0.018	0.000	0.000	42.885	4439.890	NA	0.000	2.292	73.65713	44.83%
C0206074	NYBC	Hot	0.053	0.051	0.002	42.570	4432.527	NA	0.051	2.296	74.70113	44.74%
C0206075	NYBC	Hot	0.053	0.019	0.000	42.328	4665.023	NA	0.019	2.181	75.36851	44.14%
	Average		0.041	0.024	0.001	42.594	4512.480	NA	0.024	2.256	74.576	0.446
	Std Dev.		0.021	0.026	0.001	0.279	132.158	NA	0.026	0.065	0.863	0.004
	Covariant		0.495	1.098	1.732	0.007	0.029	NA	1.098	0.029	0.012	0.008
C0206076	Idle Grams	Hot	0.0000	0.0000	0.00000	0.02752	1.19849	<i>← Idle in grams per second</i>			75.0488	45.28%
C0206077	SS @ 60	Hot	0.118	0.048	0.000	6.417	2223.888	NA	0.048	4.575	75.15636	44.33%
C0206070	UDDS	Hot	0.011	0.006	0.020	9.440	2002.629	NA	0.006	5.081	71.3058	46.92%
C0206071	UDDS	Hot	0.013	0.001	0.008	9.340	2017.597	NA	0.001	5.043	72.6783	43.81%
C0206072	UDDS	Hot	0.024	0.028	0.017	9.249	2020.563	NA	0.028	5.036	75.3672	41.18%
	Average		0.016	0.011	0.015	9.343	2013.596	NA	0.011	5.053	73.117	43.97%
	Std Dev.		0.007	0.014	0.006	0.095	9.613	NA	0.014	0.024	2.066	0.029
	Covariant		0.437	1.248	0.422	0.010	0.005	NA	1.248	0.005	0.028	0.065

Diesel	"Baseline" Chevron Diesel #2 w/Stock Muffler											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0206016	NYBC	Hot	1.262	1.334	10.604	57.405	4858.046	NA	1.334	2.086	77.2236	41.85%
C0206017	NYBC	Hot	1.092	1.182	10.105	55.373	4475.721	NA	1.182	2.264	78.3245	42.06%
C0206018	NYBC	Hot	1.146	1.269	10.845	56.124	4484.602	NA	1.269	2.258	79.7015	41.23%
	Average		1.167	1.262	10.518	56.301	4606.123	NA	1.262	2.203	78.417	41.71%
	Std Dev.		0.087	0.076	0.377	1.028	218.217	NA	0.076	0.101	1.242	0.004
	Covariant		0.074	0.060	0.036	0.018	0.047	NA	0.060	0.046	0.016	0.010
C0206019	Idle Grams	Hot	0.0001	0.0002	0.00671	0.03181	1.25269	← Idle in grams per second			82.1710	39.25%
C0206020	SS @ 60	Hot	0.472	0.177	1.730	12.507	2217.727	NA	0.177	4.582	85.4980	32.16%
C0206011	UDDS	Hot	0.441	0.295	2.397	15.790	2000.954	NA	0.295	5.074	74.6044	46.91%
C0206012	UDDS	Hot	0.410	0.307	2.224	15.841	1952.395	NA	0.307	5.200	75.6573	46.86%
C0206015	UDDS	Hot	0.414	0.322	2.154	16.072	1956.327	NA	0.322	5.190	75.5261	43.83%
	Average		0.422	0.308	2.258	15.901	1969.892	NA	0.308	5.155	75.263	45.87%
	Std Dev.		0.017	0.013	0.125	0.150	26.972	NA	0.013	0.070	0.574	0.018
	Covariant		0.040	0.043	0.055	0.009	0.014	NA	0.043	0.014	0.008	0.038

Fuel	Chevron Diesel #2 w/Alliance Longview											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	CH4	NMHC	MPG	Temp	RH%
C0206051	NYBC	Hot	0.034	0.003	0.062	47.930	4853.4	NA	NA	2.097	66.06	51.15%
C0206052	NYBC	Hot	0.068	0.109	0.000	47.576	4629.1	NA	NA	2.198	66.00	51.36%
C0206053	NYBC	Hot	0.051	0.031	0.119	47.481	4778.9	NA	NA	2.129	67.14	48.97%
	Average		0.051	0.048	0.060	47.663	4753.8	NA	NA	2.141	66.400	50%
	Std Dev.		0.017	0.055	0.060	0.237	114.251	NA	NA	0.052	0.642	0.013
	Covariant		0.331	1.152	0.988	0.005	0.024	NA	NA	0.024	0.010	0.026
C0205122	Idle Grams	Hot	0.000	0.00	0.000	0.030	1.137	← Idle in grams per second			75.29	49.77%
C0205121	SS @ 60	Hot	0.427	0.166	1.617	11.802	2097.8	NA	NA	4.844	74.31	49.80%
C0206047	UDDS	Hot	0.035	0.005	0.000	11.259	2096.7	NA	NA	4.853	67.67	52.75%
C0206049	UDDS	Hot	0.060	0.014	0.043	11.502	2107.4	NA	NA	4.828	68.61	51.52%
C0206050	UDDS	Hot	0.055	0.029	0.000	11.282	2068.3	NA	NA	4.920	68.76	51.26%
	Average		0.050	0.016	0.014	11.348	2090.8	NA	NA	4.867	68.347	51.84%
	Std Dev.		0.014	0.012	0.025	0.134	20.204	NA	NA	0.048	0.591	0.008
	Covariant		0.271	0.781	1.732	0.012	0.010	NA	NA	0.010	0.009	0.015

**Combination #5—Standard Diesel vs. FT- Diesel Fuels
with a HDV Equipped with an Engelhard DPX Particulate
Filter and NO_x Catalyst**

SUMMARY HDV TEST RESULTS & FUEL COMPARISONS

(Average Results in Gram/Mile, Except for Idle Test)

Vehicle: CalTrans #8711

Model year: 2001

Engine: International 530

Test weight: 25,549

Vin#: 1HTSDADN31H397699

Mileage: 8,396

Vehicle Type: 4900 Dump Truck

Emissions ID#: NA

Device: Oxidation Catalyst -excl. the Diesel tests

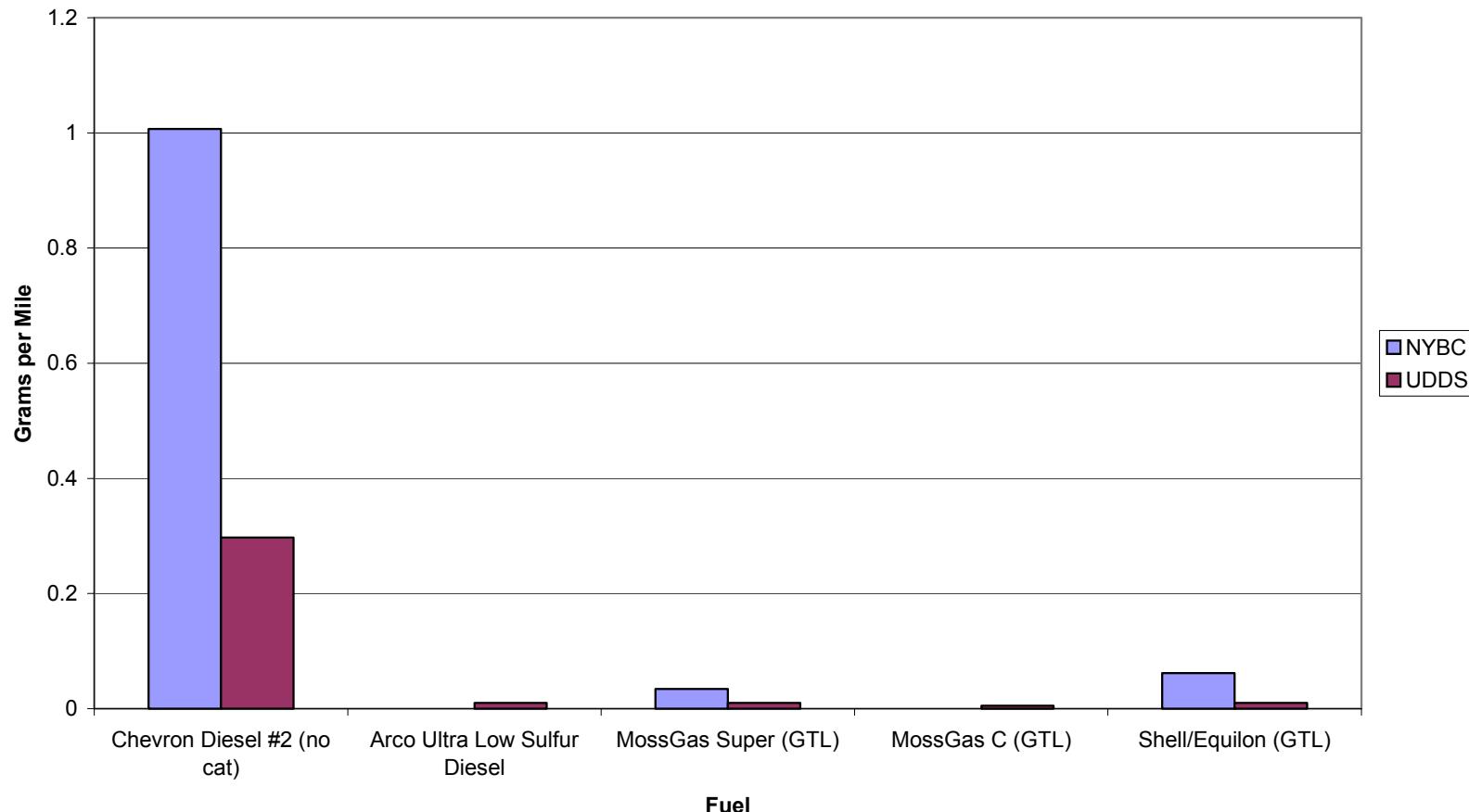
Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2	NYBC	Hot	1.007	0.483	8.959	26.58	4925.1	24.55	1.37	2.10
Arco Ultra Low Sulfur Diesel	NYBC	Hot	0.000	0.000	0.000	25.57	4911.5	6.16	18.41	2.10
% difference			-100%	-100%	-100%	-4%	0%	-75%	1241%	0%
MossGas Super (GTL)	NYBC	Hot	0.034	0.000	0.003	25.73	5005.5	6.42	18.78	2.03
% difference			-97%	-100%	-100%	-3%	2%	-74%	1268%	-3%
MossGas C (GTL)	NYBC	Hot	0.000	0.000	0.108	25.00	4915.0	6.63	17.52	2.07
% difference			-100%	-100%	-99%	-6%	0%	-73%	1176%	-2%
Shell/Equilon (GTL)	NYBC	Hot	0.062	0.000	0.082	25.19	5113.1	5.71	18.28	2.26
% difference			-94%	-100%	-99%	-5%	4%	-77%	1231%	8%

Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2	UDDS	Hot	0.297	0.145	2.960	11.18	1961.2	10.73	0.33	5.17
Arco Ultra Low Sulfur Diesel	UDDS	Hot	0.010	0.000	0.013	11.38	1978.9	5.29	5.96	5.17
% difference			-97%	-100%	-100%	2%	1%	-51%	1716%	0%
MossGas Super	UDDS	Hot	0.010	0.000	0.000	10.45	1926.0	4.72	5.58	5.30
% difference			-97%	-100%	-100%	-7%	-2%	-56%	1600%	3%
MossGas C (GTL)	UDDS	Hot	0.005	0.000	0.000	10.69	1990.7	4.95	5.57	5.10
% difference			-98%	-100%	-100%	-4%	2%	-54%	1598%	-1%
Shell/Equilon	UDDS	Hot	0.010	0.000	0.000	10.66	1964.3	4.82	5.84	5.17
% difference			-97%	-100%	-100%	-5%	0%	-55%	1682%	0%

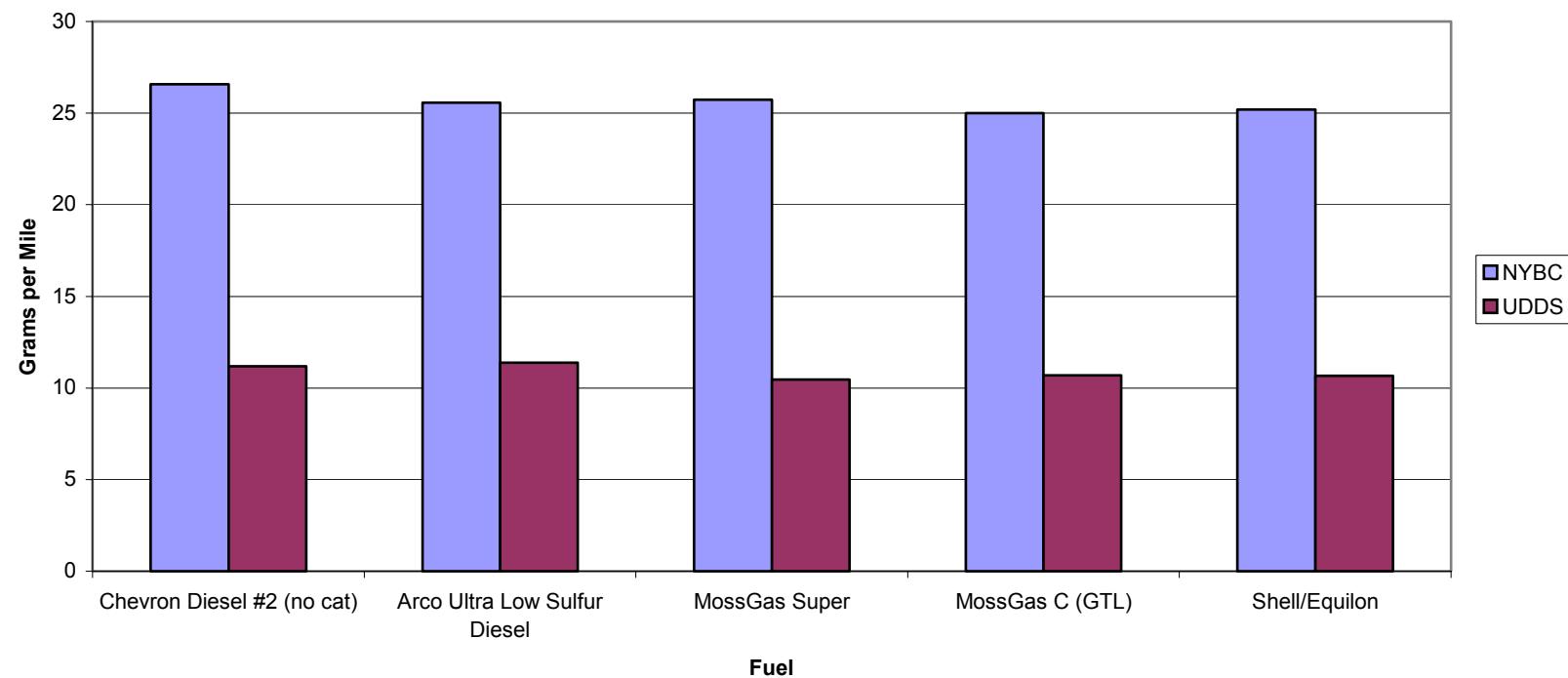
Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2	SS @ 60	Hot	0.217	0.075	1.625	9.08	2144.3	8.83	0.02	4.70
Arco Ultra Low Sulfur Diesel	SS @ 60	Hot	0.062	0.000	0.000	9.33	2186.4	7.32	1.92	4.70
% difference			-71%	-100%	-100%	3%	2%	-17%	8641%	0%
MossGas Super	SS @ 60	Hot	0.056	0.000	0.019	9.01	2118.5	7.32	1.66	4.80
% difference				-100%	-99%	-1%	-1%	-17%	7459%	2%
MossGas C (GTL)	SS @ 60	Hot	0.043	0.000	0.000	8.90	2114.6	6.94	1.88	4.80
% difference			-80%	-100%	-100%	-2%	-1%	-21%	8464%	2%
Shell/Equilon	SS @ 60	Hot	0.056	0.000	0.012	9.10	2126.2	7.86	1.73	4.80
% difference			-74%	-100%	-99%	0%	-1%	-11%	7768%	2%

Idle in Grams per Second										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2	Idle	Hot	0.000	0.198	1.253	3.98	449.4	3.25	0.25	22.50
Arco Ultra Low Sulfur Diesel	Idle	Hot	0.010	0.032	0.000	3.86	440.7	1.39	1.91	23.10
% difference			#DIV/0!	-84%	-100%	-3%	-2%	-57%	661%	3%
MossGas Super	Idle	Hot	0.041	0.141	0.000	3.93	438.3	2.23	1.70	23.20
% difference			#DIV/0!	-29%	-100%	-1%	-2%	-31%	576%	3%
MossGas C (GTL)	Idle	Hot	0.000	0.003	0.000	3.69	436.8	2.23	1.38	23.30
% difference			#DIV/0!	-98%	-100%	-7%	-3%	-31%	448%	4%
Shell/Equilon	Idle	Hot	0.000	0.000	0.000	3.52	438.6	2.39	1.14	23.20
% difference			#DIV/0!	-100%	-100%	-12%	-2%	-27%	352%	3%

Technology #5
PM Effect of Engelhard Diesel Particulate Filter (DPX)/Catalyst and Alternative Fuels
2001 4900 Dump Truck w/ International 530



Technology #5
NOx Effects of Engelhard Diesel Particulate Filter (DPX)/Catalyst and Alternative Fuels
2001 4900 Dump Truck w/ International 530



Vehicle: CalTrans #8711
Model year: 2001
Engine: International 530
Test weight: 25,549

Vin# 1HTSDADN31H397
Mileage: 8,396
Vehicle Type: 4900 Dump Truck
Emissions ID#: NA
Device: Oxidation Catalyst

RLMD: → (A+Bv+Cv²+Dv³)

Vehicle	Road
A. -465.322	-677.43590
B. 92.4284	75.72911
C. -7.483884	-0.59077
D. 4.557332E-03	4.183195E-03

Start Date: 02/03/03
Project: CEC
CVS flow rate: 3000cfm

Prepared for: CEC

"Baseline" Diesel #2 No Catalyst			Grams per Mile										
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	NO	NO2	MPG	Temp	RH%	
C0302038	NYBC	Hot	1.024	0.344	8.669	26.160	4930.1	24.574	1.222	2.100	77.15	12.84%	
C0302039	NYBC	Hot	1.024	0.582	9.479	26.716	4939.7	24.616	1.299	2.100	77.14	12.86%	
C0302040	NYBC	Hot	0.973	0.523	8.729	26.852	4905.3	24.455	1.599	2.100	77.33	12.57%	
Average			1.007	0.483	8.959	26.576	4925.1	24.548	1.373	2.100	77.207	12.76%	
Std Dev.			0.029	0.124	0.451	0.367	17.758	0.084	0.199	0.000	0.107	0.002	
Covariant			0.029	0.257	0.050	0.014	0.004	0.003	0.145	0.000	0.001	0.013	
C0302044	Idle Grams/Sec	Hot	0.000	0.000	0.003	0.011	1.248	0.009	0.000	22.500	72.72	23.32%	
C0302045	SS @ 60	Hot	0.217	0.075	1.625	9.075	2144.3	8.828	0.022	4.700	71.6600	22.40%	
C0302041	UDDS	Hot	0.275	0.103	2.805	11.223	1939.8	10.855	0.179	5.200	69.67	26.94%	
C0302042	UDDS	Hot	0.297	0.156	2.938	11.182	1964.8	10.699	0.382	5.200	70.55	25.83%	
C0302043	UDDS	Hot	0.320	0.176	3.136	11.132	1979.0	10.638	0.422	5.100	71.58	24.82%	
Average			0.297	0.145	2.960	11.179	1961.2	10.731	0.328	5.167	70.600	25.86%	
Std Dev.			0.023	0.038	0.167	0.046	19.817	0.112	0.130	0.058	0.956	0.011	
Covariant			0.076	0.260	0.056	0.004	0.010	0.010	0.398	0.011	0.014	0.041	

Arco Ultra Low Sulfur Diesel w/ Cat.			Grams per Mile										
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG	Temp	RH%	
C0302026	NYBC	Hot	0.000	0.000	0.000	25.560	4987.7	6.330	18.429	2.000	68.94	22.75%	
C0302027	NYBC	Hot	0.000	0.000	0.000	25.626	4896.1	6.290	18.246	2.100	68.90	22.93%	
C0302028	NYBC	Hot	0.000	0.000	0.000	25.529	4850.5	5.858	18.568	2.100	69.42	22.71%	
	Average		0.000	0.000	0.000	25.572	4911.5	6.159	18.414	2.067	69.087	0.228	
	Std Dev.		0.000	0.000	0.000	0.050	69.871	0.262	0.162	0.058	0.289	0.001	
	Covariant		0.000	0.000	0.000	0.002	0.014	0.042	0.009	0.028	0.004	0.005	
C0302024	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.011	1.224	0.004	0.005	23.100	73.73	13.58%	
C0302025	SS @ 60	Hot	0.062	0.000	0.000	9.332	2186.4	7.318	1.923	4.700	74.17	16.66%	
C0302021	UDDS	Hot	0.011	0.000	0.039	11.220	2005.4	5.118	5.889	5.100	73.61	14.49%	
C0302022	UDDS	Hot	0.005	0.000	0.000	11.282	1925.6	5.215	5.915	5.300	74.27	14.91%	
C0302023	UDDS	Hot	0.015	0.000	0.000	11.645	2005.8	5.541	6.063	5.100	74.79	13.90%	
	Average		0.010	0.000	0.013	11.382	1978.9	5.291	5.956	5.167	74.223	14.43%	
	Std Dev.		0.005	0.000	0.023	0.230	46.180	0.222	0.094	0.115	0.591	0.005	
	Covariant		0.487	0.000	1.732	0.020	0.023	0.042	0.016	0.022	0.008	0.035	

Moss Super GTL w/ Catalyst			Grams per Mile									
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG	Temp	RH%
C0302013	NYBC	Hot	0.034	0.000	0.008	25.515	4955.6	6.614	18.828	2.100	74.15	24.65%
C0302014	NYBC	Hot	0.067	0.000	0.000	25.768	5045.9	6.171	18.322	2.000	75.45	24.54%
C0302015	NYBC	Hot	0.000	0.000	0.000	25.910	5014.9	6.488	19.199	2.000	75.88	21.94%
	Average		0.034	0.000	0.003	25.731	5005.5	6.424	18.783	2.033	75.160	23.71%
	Std Dev.		0.034	0.000	0.005	0.200	45.865	0.228	0.440	0.058	0.901	0.015
	Covariant		0.995	0.000	1.732	0.008	0.009	0.036	0.023	0.028	0.012	0.065
C0302016	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.011	1.218	0.006	0.005	23.200	75.09	21.42%
C0302017	SS @ 60	Hot	0.056	0.000	0.019	9.005	2118.5	7.320	1.663	4.800	75.37	22.06%
C0302018	UDDS	Hot	0.009	0.000	0.000	10.347	1933.6	4.786	5.492	5.300	71.41	15.53%
C0302019	UDDS	Hot	0.013	0.000	0.000	10.360	1915.9	4.666	5.569	5.300	71.46	15.88%
C0302020	UDDS	Hot	0.009	0.000	0.000	10.641	1928.5	4.704	5.666	5.300	71.78	15.17%
	Average		0.010	0.000	0.000	10.449	1926.0	4.719	5.576	5.300	71.550	15.53%
	Std Dev.		0.002	0.000	0.000	0.166	9.080	0.061	0.087	0.000	0.201	0.004
	Covariant		0.223	0.000	0.000	0.016	0.005	0.013	0.016	0.000	0.003	0.023

Moss C GTL w/ Catalyst			Grams per Mile										
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG	Temp	RH%	
C0302032	NYBC	Hot	0.000	0.000	0.309	25.210	4975.9	6.532	17.873	2.000	75.19	16.63%	
C0302033	NYBC	Hot	0.000	0.000	0.000	25.135	4932.8	6.690	17.645	2.100	75.31	15.72%	
C0302034	NYBC	Hot	0.000	0.000	0.015	24.642	4836.2	6.677	17.032	2.100	75.48	15.76%	
	Average		0.000	0.000	0.108	24.996	4915.0	6.633	17.517	2.067	75.327	0.160	
	Std Dev.		0.000	0.000	0.174	0.309	71.532	0.088	0.435	0.058	0.146	0.005	
	Covariant		0.000	0.000	0.000	0.012	0.015	0.013	0.025	0.028	0.002	0.032	
C0302035	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.010	1.213	0.006	0.004	23.300	75.56	15.21%	
C0302037	SS @ 60	Hot	0.043	0.000	0.000	8.900	2114.6	6.936	1.884	4.800	75.99	15.71%	
C0302029	UDDS	Hot	0.005	0.000	0.000	11.043	1987.5	4.930	5.840	5.100	73.81	18.38%	
C0302030	UDDS	Hot	0.005	0.000	0.000	10.586	1983.3	4.927	5.561	5.100	74.00	18.05%	
C0302031	UDDS	Hot	0.004	0.000	0.000	10.451	2001.4	4.989	5.309	5.100	74.45	17.16%	
	Average		0.005	0.000	0.000	10.693	1990.7	4.949	5.570	5.100	74.087	17.86%	
	Std Dev.		0.001	0.000	0.000	0.310	9.461	0.035	0.266	0.000	0.329	0.006	
	Covariant		0.124	0.000	0.000	0.029	0.005	0.007	0.048	0.000	0.004	0.035	

Shell GTL w/ Catalyst			Grams per Mile										
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG	Temp	RH%	
C0302010	NYBC	Hot	0.068	0.000	0.000	24.529	5044.6	5.717	17.948	2.230	71.74	33.36%	
C0302011	NYBC	Hot	0.068	0.000	0.247	25.169	5082.5	5.507	18.309	2.285	72.06	33.94%	
C0302012	NYBC	Hot	0.050	0.000	0.000	25.874	5212.2	5.904	18.579	2.274	72.75	34.41%	
	Average		0.062	0.000	0.082	25.191	5113.1	5.709	18.279	2.263	72.183	33.90%	
	Std Dev.		0.010	0.000	0.143	0.673	87.9	0.199	0.317	0.029	0.516	0.005	
	Covariant		0.166	0.000	1.732	0.027	0.017	0.035	0.017	0.013	0.007	0.016	
C0302008	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.010	1.218	0.007	0.003	23.20	71.98	25.30	
C0302009	SS @ 60 mph	Hot	0.056	0.000	0.012	9.093	2126.2	7.357	1.731	4.80	73.230	25.94%	
C0302004	UDDS	Hot	0.025	0.000	0.000	10.720	1998.8	4.916	5.804	5.100	72.03	25.93%	
C0302005	UDDS	Hot	0.002	0.000	0.000	10.639	1944.1	4.749	5.890	5.200	72.97	25.78%	
C0302006	UDDS	Hot	0.004	0.000	0.000	10.633	1950.1	4.782	5.837	5.200	73.57	24.85%	
	Average		0.010	0.000	0.000	10.664	1964.3	4.816	5.844	5.167	72.857	25.52%	
	Std Dev.		0.013	0.000	0.000	0.049	30.035	0.088	0.043	0.058	0.776	0.006	
	Covariant		1.233	0.000	0.000	0.005	0.015	0.018	0.007	0.011	0.011	0.023	

**Combination #6—Standard Diesel vs. FT- Diesel Fuels
with a HDV Equipped with a Cleaire Alliance Longview
Combining a NO_x Catalyst and a Particulate Filter.**

SUMMARY HDV TEST RESULTS & FUEL COMPARISONS

(Average Results in Gram/Mile, Except for Idle Test)

Vehicle: F02CAT01

Model year: 1997

Engine: Freightliner Century Class

Test weight: 56,309

Vin#: 1FUMNMCA7VP809087

Mileage: N/A

Vehicle Type: Tractor

Emissions ID#: NA

Device: Cleaire Catalyst

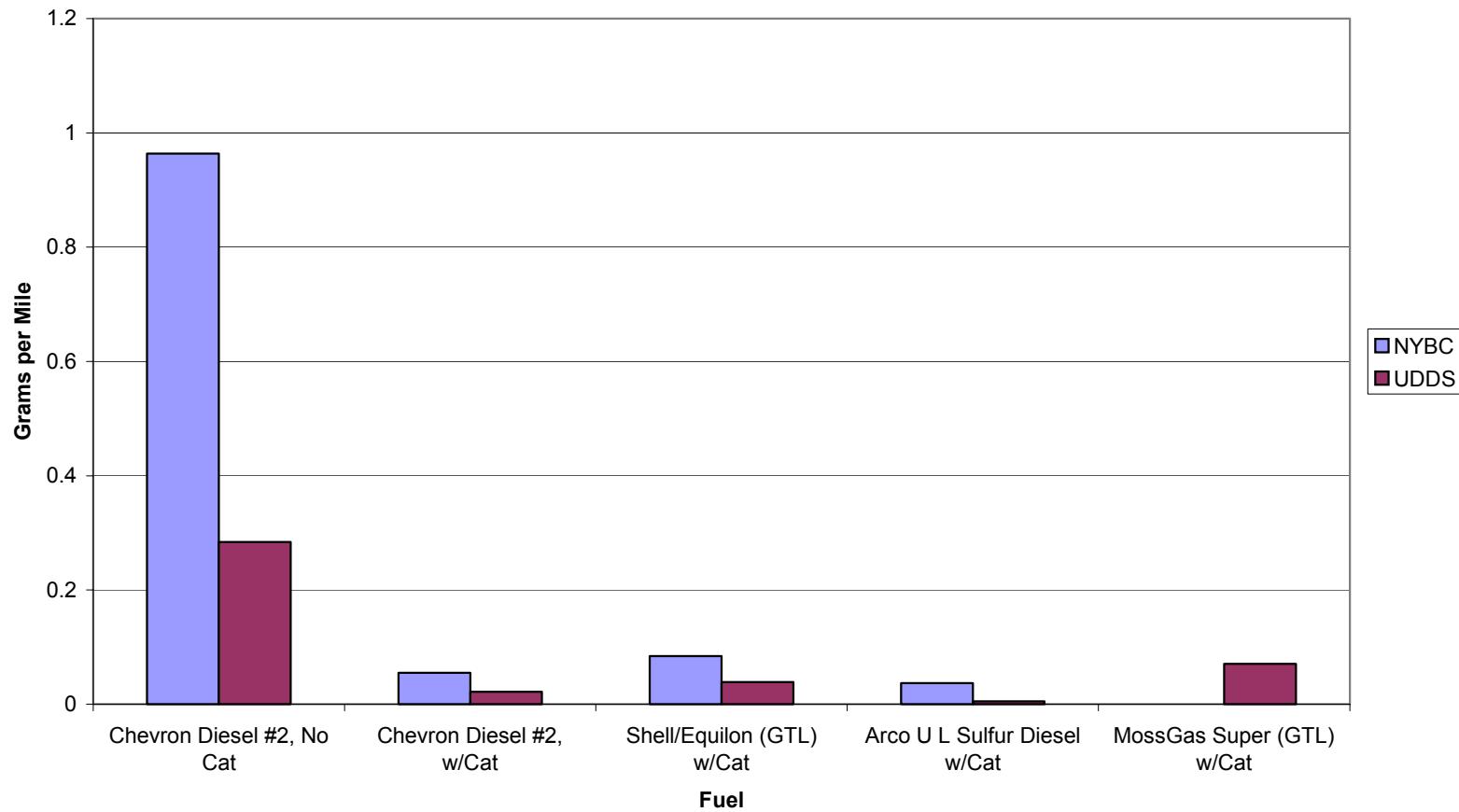
Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	NO	NO2	MPG
Chevron Diesel #2, No Cat	NYBC	Hot	0.964	1.782	16.985	37.20	5048.3	34.14	3.06	2.00
Chevron Diesel #2, w/Cat	NYBC	Hot	0.055	0.000	0.067	31.24	4614.6	11.89	19.36	2.20
% difference			-94%	-100%	-100%	-16%	-9%	-65%	533%	10%
Shell/Equilon (GTL) w/Cat	NYBC	Hot	0.084	0.000	0.084	30.47	4698.9	11.07	19.41	2.17
% difference			-91%	-100%	-100%	-18%	-7%	-68%	534%	8%
Arco U L Sulfur Diesel w/Cat	NYBC	Hot	0.037	0.000	0.000	31.65	4654.4	11.54	20.12	2.20
% difference			-96%	-100%	-100%	-15%	-8%	-66%	558%	10%
MossGas Super (GTL) w/Cat	NYBC	Hot	0.000	0.000	0.000	27.12	4559.3	9.78	17.34	2.20
% difference			-100%	-100%	-100%	-27%	-10%	-71%	467%	10%

Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO₂	NO	NO2	MPG
Chevron Diesel #2, No Cat	UDDS	Hot	0.284	0.408	3.955	15.89	2166.3	15.48	0.40	4.70
Chevron Diesel #2, w/Cat	UDDS	Hot	0.022	0.003	0.000	11.14	2086.2	6.10	5.05	4.87
% difference			-92%	-99%	-100%	-30%	-4%	-61%	1148%	4%
Shell/Equilon (GTL) w/Cat	UDDS	Hot	0.039	0.009	0.000	10.77	2105.5	5.90	4.87	4.83
% difference			-86%	-98%	-100%	-32%	-3%	-62%	1105%	3%
Arco U L Sulfur Diesel w/Cat	UDDS	Hot	0.005	0.000	0.000	10.69	1990.7	4.95	5.57	5.10
			-98%	-100%	-100%	-33%	-8%	-68%	1276%	9%
MossGas Super (GTL) w/Cat	UDDS	Hot	0.071	0.000	0.000	9.76	2052.3	5.31	4.45	4.97
% difference			-75%	-100%	-100%	-39%	-5%	-66%	1001%	6%

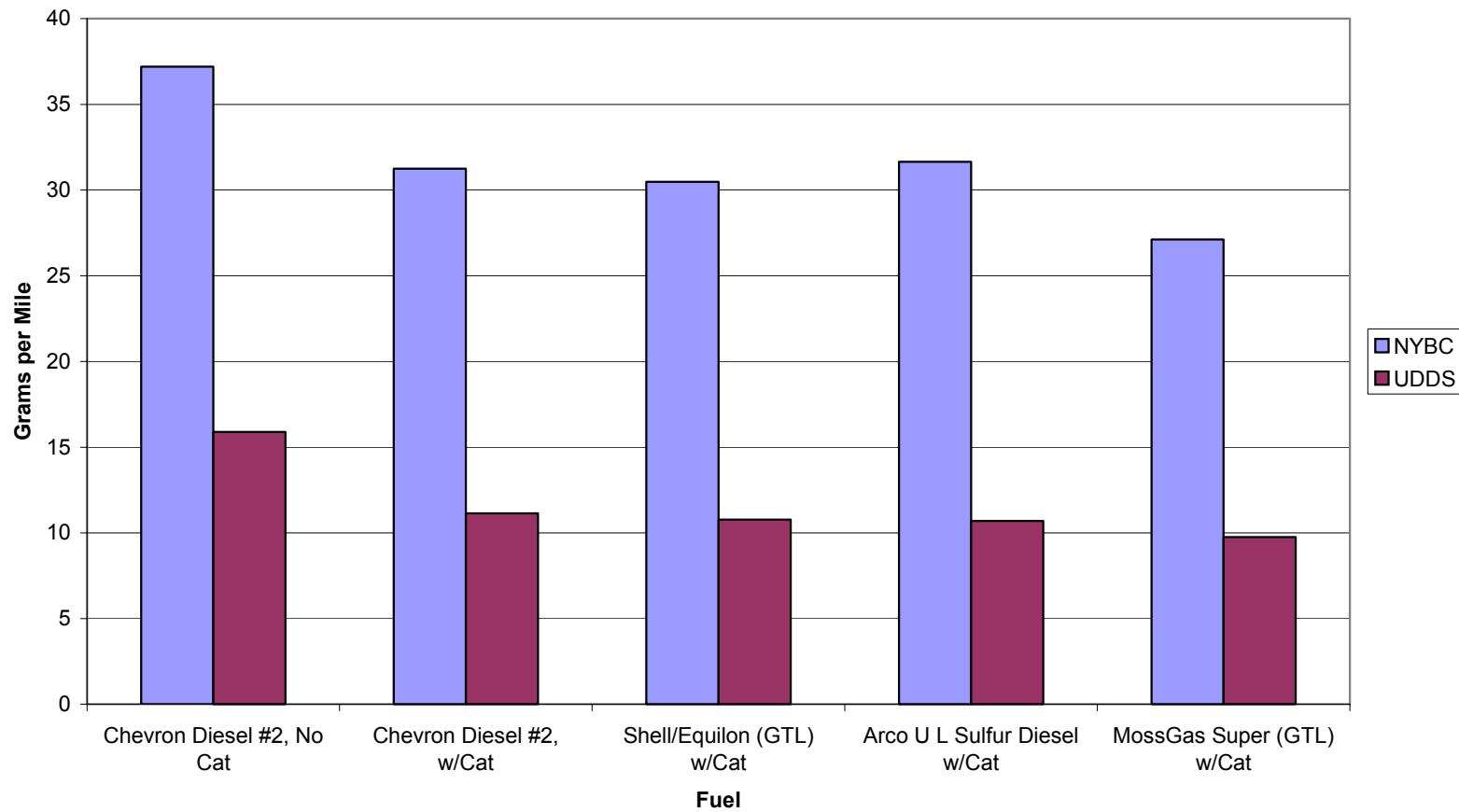
Average Grams per Mile										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2, No Cat	SS @ 60	Hot	0.171	0.301	1.679	36.420	2326.6	36.005	0.415	4.40
Chevron Diesel #2, w/Cat	SS @ 60	Hot	0.189	0.000	0.000	22.838	2279.9	18.919	3.919	4.50
% difference			11%	-100%	-100%	-37%	-2%	-47%	844%	2%
Shell/Equilon (GTL) w/Cat	SS @ 60	Hot	0.048	0.000	0.000	23.00	2302.0	17.83	5.16	4.40
% difference			-72%	-100%	-100%	-37%	-1%	-50%	1144%	0%
Arco U L Sulfur Diesel w/Cat	SS @ 60	Hot	0.184	0.001	0.000	20.83	2401.8	17.06	3.77	4.20
% difference			8%	-100%	-100%	-43%	3%	-53%	808%	-5%
MossGas Super (GTL) w/Cat	SS @ 60	Hot	0.078	0.000	0.000	20.27	2239.4	16.19	4.09	4.50
% difference			-54%	-100%	-100%	-44%	-4%	-55%	885%	2%

Idle in Grams per Second										
Test Fuel:	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	MPG
Chevron Diesel #2, No Cat	Idle	Hot	0.041	0.421	1.082	6.68	374.6	5.81	0.87	26.90
Chevron Diesel #2, w/Cat	Idle	Hot	0.021	0.012	0.000	6.085	345.8	1.494	4.590	29.40
% difference			-49%	-97%	-100%	-9%	-8%	-74%	425%	9%
Shell/Equilon (GTL) w/Cat	Idle	Hot	0.021	0.091	0.106	5.57	348.4	1.99	3.58	29.20
% difference			-49%	-78%	-90%	-17%	-7%	-66%	310%	9%
Arco U L Sulfur Diesel w/Cat	Idle	Hot	0.010	0.037	0.000	5.96	325.7	2.77	3.20	31.20
% difference			-76%	-91%	-100%	-11%	-13%	-52%	266%	16%
MossGas Super (GTL) w/Cat	Idle	Hot	0.010	0.087	0.000	6.14	390.8	2.03	4.12	26.00
% difference			-76%	-79%	-100%	-8%	4%	-65%	371%	-3%

Technology #6
PM Effect of Cleaire Alliance Longview Catalyst and Alternative Fuels
1997 Tractor w/ Freightliner Century Class



Technology #6
NOx Effect of Cleaire Alliance Longview Catalyst and Alternative Fuels
1997 Tractor w/ Freightliner Century Class



Vehicle: F02CAT01
Model year: 1997
Engine: Freightliner Century Class
Test weight: 56,309

Vin# 1FUMNMCA7VP809087
Mileage: N/A
Vehicle Type: Tractor
Emissions ID#: NA

Start Date: 03/31/03
Project: CEC
CVS flow rate: 3000cfm

Prepared for: CEC

"Baseline" Diesel #2 No Catalyst			Grams per Mile											
Test #	Cycle	Type	PM	THC	CO	NOX	CO2	NO	NO2	NMHC	MPG	Temp	RH%	
C0303033	NYBC	Hot	1.006	1.685	18.734	35.878	5006.0	33.362	2.516	1.698	2.000	74.82	28.71%	
C0303035	NYBC	Hot	0.941	1.914	15.618	37.398	5096.3	34.499	2.899	1.915	2.000	74.79	31.41%	
C0303036	NYBC	Hot	0.945	1.748	16.602	38.319	5042.5	34.557	3.761	1.748	2.000	75.09	33.46%	
	Average		0.964	1.782	16.985	37.198	5048.3	34.139	3.059	1.787	2.000	74.900	31.19%	
	Std Dev.		0.036	0.118	1.593	1.233	45.388	0.674	0.638	0.113	0.000	0.165	0.024	
	Covariant		0.038	0.066	0.094	0.033	0.009	0.020	0.208	0.063	0.000	0.002	0.076	
C0303037	Idle Grams/Sec	Hot	0.000	0.001	0.003	0.019	1.041	0.016	0.013	0.001	26.900	76.35	31.03%	
C0303038	SS @ 60	Hot	0.171	0.301	1.679	36.420	2326.6	36.005	0.415	0.301	4.400	76.49	30.37%	
C0303030	UDDS	Hot	0.279	0.420	3.955	15.989	2167.9	15.558	0.431	0.422	4.700	74.33	32.23%	
C0303031	UDDS	Hot	0.287	0.382	3.891	15.890	2169.0	15.564	0.326	0.382	4.700	73.94	29.47%	
C0303032	UDDS	Hot	0.286	0.423	4.019	15.786	2162.1	15.329	0.457	0.423	4.700	74.16	29.85%	
	Average		0.284	0.408	3.955	15.888	2166.3	15.484	0.405	0.409	4.700	74.143	30.52%	
	Std Dev.		0.004	0.023	0.064	0.102	3.689	0.134	0.069	0.023	0.000	0.196	0.015	
	Covariant		0.015	0.056	0.016	0.006	0.002	0.009	0.171	0.057	0.000	0.003	0.049	

<i>"Baseline" Diesel #2 w/ Cleaire Cat.</i>			Grams per Mile											
<i>Test #</i>	<i>Cycle</i>	<i>Type</i>	<i>PM</i>	<i>THC</i>	<i>CO</i>	<i>NOX</i>	<i>CO₂</i>	<i>NO</i>	<i>NO2</i>	<i>NMHC</i>	<i>MPG</i>	<i>Temp</i>	<i>RH%</i>	
C0303043	NYBC	Hot	0.036	0.000	0.108	31.207	4610.4	11.825	19.382	0.000	2.200	76.6	39.58%	
C0303044	NYBC	Hot	0.019	0.000	0.093	31.749	4539.0	11.713	20.036	0.000	2.200	76.60	39.02%	
C0303045	NYBC	Hot	0.110	0.000	0.000	30.775	4694.5	12.123	18.652	0.000	2.200	77.01	36.55%	
	Average		0.055	0.000	0.067	31.244	4614.6	11.887	19.357	0.000	2.200	76.737	0.384	
	Std Dev.		0.048	0.000	0.059	0.488	77.792	0.212	0.692	0.000	0.000	0.237	0.016	
	Covariant		0.000	0.000	0.000	0.016	0.017	0.018	0.036	0.000	0.000	0.003	0.042	
C0303047	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.017	0.961	0.004	0.013	0.000	29.400	76.86	31.08%	
C0303046	SS @ 60	Hot	0.189	0.000	0.000	22.838	2279.9	18.919	3.919	0.000	4.500	76.87	33.91%	
C0303040	UDDS	Hot	0.007	0.009	0.000	11.101	2069.9	6.157	4.944	0.009	4.900	75.85	40.54%	
C0303041	UDDS	Hot	0.019	0.000	0.000	11.207	2089.2	6.065	5.142	0.000	4.900	75.79	41.20%	
C0303042	UDDS	Hot	0.039	0.000	0.000	11.125	2099.4	6.065	5.060	0.000	4.800	76.16	40.82%	
	Average		0.022	0.003	0.000	11.144	2086.2	6.096	5.049	0.003	4.867	75.933	40.85%	
	Std Dev.		0.016	0.005	0.000	0.056	14.959	0.053	0.099	0.005	0.058	0.199	0.003	
	Covariant		0.746	0.000	0.000	0.005	0.007	0.009	0.020	0.000	0.012	0.003	0.008	

Shell GTL w/ Cleaire Catalyst			Grams per Mile											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	NMHC	MPG	Temp	RH%	
C0303058	NYBC	Hot	0.018	0.000	0.000	31.374	4665.0	11.061	20.312	0.000	2.200	72.68	29.62%	
C0303059	NYBC	Hot	0.000	0.000	0.000	30.091	4745.4	10.879	19.212	0.000	2.100	72.96	30.14%	
C0303060	NYBC	Hot	0.015	0.000	0.252	29.955	4686.2	11.258	18.697	0.000	2.200	72.9	30.03%	
	Average		0.011	0.000	0.084	30.473	4698.9	11.066	19.407	0.000	2.167	72.847	29.93%	
	Std Dev.		0.010	0.000	0.145	0.783	41.676	0.190	0.825	0.000	0.058	0.147	0.003	
	Covariant		0.877	0.000	1.732	0.026	0.009	0.017	0.043	0.000	0.027	0.002	0.009	
C0303057	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.015	0.968	0.006	0.010	0.000	29.200	73.56	27.07%	
C0303056	SS @ 60	Hot	0.048	0.000	0.000	22.996	2302.0	17.834	5.162	0.000	4.400	73.54	27.36%	
C0303061	UDDS	Hot	0.026	0.000	0.000	11.017	2086.4	5.865	5.152	0.000	4.900	71.37	25.90%	
C0303062	UDDS	Hot	0.004	0.028	0.000	10.782	2128.8	5.938	4.845	0.028	4.800	72.52	25.85%	
C0303063	UDDS	Hot	0.087	0.000	0.000	10.516	2101.4	5.891	4.626	0.000	4.800	73.73	22.94%	
	Average		0.039	0.009	0.000	10.772	2105.5	5.898	4.874	0.009	4.833	72.540	24.90%	
	Std Dev.		0.043	0.016	0.000	0.251	21.512	0.037	0.264	0.016	0.058	1.180	0.017	
	Covariant		1.103	0.000	0.000	0.023	0.010	0.006	0.054	0.000	0.012	0.016	0.068	

ARCO Ultra Low Sulfur w/ Cleaire Cat.			Grams per Mile											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	NMHC	MPG	Temp	RH%	
C0303051	NYBC	Hot	0.037	0.000	0.000	31.166	4682.4	11.784	19.381	0.000	2.200	71.48	26.35%	
C0303052	NYBC	Hot	0.037	0.000	0.000	32.131	4669.2	11.807	20.324	0.000	2.200	71.83	25.77%	
C0303053	NYBC	Hot	0.037	0.000	0.000	31.661	4611.5	11.017	20.644	0.000	2.200	72.42	24.58%	
	Average		0.037	0.000	0.000	31.653	4654.4	11.536	20.116	0.000	2.200	71.910	25.57%	
	Std Dev.		0.000	0.000	0.000	0.483	37.7	0.450	0.657	0.000	0.000	0.475	0.009	
	Covariant		0.000	0.000	0.000	0.015	0.008	0.039	0.033	0.000	0.000	0.007	0.035	
C0303055	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.017	0.905	0.008	0.009	0.000	31.20	74.18	23.34	
C0303054	SS @ 60 mph	Hot	0.184	0.001	0.000	20.833	2401.8	17.063	3.770	0.001	4.20	73.030	24.47%	
C0303048	UDDS	Hot	0.002	0.000	0.000	10.920	2090.5	5.651	5.268	0.000	4.900	68.3	30.10%	
C0303049	UDDS	Hot	0.024	0.028	0.000	10.641	2106.9	5.726	4.915	0.031	4.800	69.47	29.43%	
C0303050	UDDS	Hot	0.039	0.017	0.023	10.538	2114.8	5.560	4.978	0.020	4.800	70.51	28.63%	
	Average		0.022	0.015	0.008	10.700	2104.1	5.646	5.054	0.017	4.833	69.427	29.39%	
	Std Dev.		0.019	0.014	0.013	0.198	12.405	0.083	0.188	0.016	0.058	1.106	0.007	
	Covariant		0.859	0.000	0.000	0.018	0.006	0.015	0.037	0.000	0.012	0.016	0.025	

Super Moss GTL w/ Cleaire Cat.			Grams per Mile											
Test #	Cycle	Type	PM	THC	CO	NOX	CO ₂	NO	NO2	NMHC	MPG	Temp	RH%	
C0303067	NYBC	Hot	0.000	0.000	0.000	27.228	4581.0	9.680	17.548	0.000	2.200	78.51	16.20%	
C0303068	NYBC	Hot	0.000	0.000	0.000	27.220	4548.6	9.967	17.253	0.000	2.200	79.76	14.24%	
C0303069	NYBC	Hot	0.000	0.000	0.000	26.914	4548.4	9.690	17.223	0.000	2.200	80.51	14.57%	
	Average		0.000	0.000	0.000	27.121	4559.3	9.779	17.341	0.000	2.200	79.593	0.150	
	Std Dev.		0.000	0.000	0.000	0.179	18.744	0.163	0.180	0.000	0.000	1.010	0.010	
	Covariant		0.000	0.000	0.000	0.007	0.004	0.017	0.010	0.000	0.000	0.013	0.070	
C0303071	Idle Grams/Sec	Hot	0.000	0.000	0.000	0.017	1.086	0.006	0.011	0.000	26.000	83.33	11.91%	
C0303070	SS @ 60	Hot	0.078	0.000	0.000	20.274	2239.4	16.185	4.089	0.000	4.500	75.99	15.71%	
C0303064	UDDS	Hot	0.071	0.000	0.000	10.117	2057.8	5.568	4.549	0.000	4.900	75.94	20.28%	
C0303065	UDDS	Hot	0.078	0.000	0.000	9.658	2049.4	5.252	4.407	0.000	5.000	76.55	18.12%	
C0303066	UDDS	Hot	0.063	0.000	0.000	9.505	2049.7	5.100	4.405	0.000	5.000	77.13	17.56%	
	Average		0.071	0.000	0.000	9.760	2052.3	5.307	4.454	0.000	4.967	76.540	18.65%	
	Std Dev.		0.008	0.000	0.000	0.318	4.784	0.239	0.083	0.000	0.058	0.595	0.014	
	Covariant		0.106	0.000	0.000	0.033	0.002	0.045	0.019	0.000	0.012	0.008	0.077	